Appendix B: Hayward Asset Profile Sheets

These one to four-page “snap-shots” capture the key issues, vulnerabilities, and consequences identified for each asset in the Hayward Shoreline Resilience Study. The profile sheets also identify priority management issues, present proposed adaptation strategies, and identify next steps for individual agencies and the study area.

Asset Profile Sheets in Alphabetical Order

Bay Trail

City of Hayward

Cogswell Marsh

East Bay Dischargers Authority

Eden Landing Ecological Reserve

Flood Control (Zone 4 Lines A and E)

HARD Marsh

Hayward Marsh

Hayward Shoreline Interpretive Center

Hayward Water Pollution Control Facility

Old West Winton Landfill

Oliver Salt Ponds

Russell City Energy Center

Salt Marsh Harvest Mouse Preserve

Solar Panels in Oxidation Ponds

State Route 92

Structural Shorelines

Triangle Marsh

BAY TRAIL

Asset Description: The segment of Bay Trail along the Hayward Shoreline, from the Old West Winton Landfill to the Arden Road parking lot, is mostly gravel trail on levee with a paved pedestrian bridge over SR-92. The trail north of SR-92 runs along outboard levees and is owned and maintained by East Bay Regional Parks District (EBRPD). The paved pedestrian bridge over SR-92 is owned by Caltrans. The inboard portion of the Bay Trail south of SR-92 was completed by California Department of Fish and Wildlife (CADFW) as part of the Eden Landing Ecological Reserve in 2008, but is operated by EBRPD. No regular trail maintenance occurs except minor repairs after storm event erosion. The Bay Trail in the Hayward Resilience Study area is used by 80,000 visitors/year including commuters, runners, bikers, walkers and visitors to the Hayward Shoreline Interpretive Center.

Key Issue Statement: The Bay Trail is vulnerable to sea level rise and storm impacts because of its shoreline location, the erodibility of its gravel trails, and the low elevation of the levees that carry that trail. As storm event flooding increases in depth and extent, the Bay Trail will be damaged and require temporary closures and repairs. This will negatively affect the regional Bay Trail network because connectivity will be disrupted. Furthermore, any changes to the levees advanced for other purposes may require rerouting or rebuilding the Bay Trail.

Vulnerabilities

GOV1: EBRPD has no regular Bay Trail maintenance program and minor erosion may be hard to repair in a timely, low-cost manner. The result of this deferred maintenance is that damage may compound and result in significant and lengthy disruptions to damaged trail segments, possibly compromising the entire system.

GOV2: EBRPD does not have plans for how to improve or maintain the Bay Trail in the Hayward Regional Shoreline or Eden Landing to address future storm events and sea level rise.

GOV3: Repairs of the Bay Trail can be difficult to implement due to its location adjacent to the Bay and protected natural areas. Storm events and sea level rise will likely increase the need for repairs because higher water levels will increase erosion of the levees that carry the trail.

GOV4: EBRPD manages all of the Bay Trail within the Hayward Regional Shoreline, but the pedestrian bridge over SR-92 is owned by Caltrans and the Bay Trail south of the bridge is owned by CADFW and managed by EBRPD. These relationships between land owners, managers, and neighbors mean that future adaptation will require expanded coordination and cost-sharing between agencies.

FUNC1: The segment of Bay Trail in the Hayward Regional Shoreline has no nearby alternative, e.g., there are no inland bypasses, and so disruption to any part of this trail segment will disrupt the use of the trail for the entire shoreline area.

FUNC2: The Bay Trail pedestrian bridge over SR-92 cannot be easily moved or rerouted due to its position in relation to other fixed assets such as the overpasses and exits along SR-92.

PHYS1: Since the Bay Trail in the study area is located on levees and designed as gravel trails, which are vulnerable to erosion and overtopping, the trails are likely to be damaged as sea level rises and the trail and levees are overtopped or eroded.

Consequences

Society and Equity: The Bay Trail provides free shoreline recreation to all residents of the Bay area. If the Bay Trail through Hayward is disrupted or permanently damaged, residents will lose recreation and non-motorized travel opportunities. Since flooding will sever connectivity along the Bay Trail, these negative effects would extend to neighboring Bay Trail segments as well. The Bay Trail also allows limited-mobility residents to access the shoreline; however, even temporary flooding or mud and debris can preclude these individuals from using the trail.

Environment: The Bay Trail provides millions of Bay Area residents an opportunity to see the Bay, wildlife, and natural areas, which helps build support for environmental protection and restoration. If the Bay Trail is disrupted or damaged, this opportunity will be diminished or lost altogether.

Economy: The Bay Trail in Hayward provides over $490,000 in recreation benefits each year to the local and regional economy. Long term disruption or permanent closure would reduce these benefits.

Bay Trail Proposed Adaptation Actions

- Establish agreements among partner agencies to finance, maintain, repair, and upgrade the shoreline levees that carry the Bay Trail in a manner that best preserves connected shoreline access
- Work with partner agencies to conduct hotspots analysis, jointly plan and fund repairs of trails and levees with existing problems or deferred maintenance.
- Work with partner agencies across the region to procure transportation and other funding sources for repairs and improvements to the Bay Trail where no funding sources currently exist.
- Stockpile materials to create temporary bridges, ramps or pathways to maintain safe access for those with limited mobility.
- Effectively communicate trail closures, e.g., establish specific notification practices.
- Prioritize resurfacing vulnerable trail segments with erosion-resistant materials or other upgrades that improve sea level rise and storm event resilience.
- Prioritize maintenance and repair of barrier-free access to minimize trail re-routing or closure.
- Participate in collaborative regional discussions to explore the policy/regulatory changes that could revise the regulatory requirements for maintenance, repairs, and upgrades of shoreline levees that carry the Bay Trail to address existing and future flooding and erosion challenges.
- Develop a public outreach and education campaign to build public support for the improvement and maintenance of connected Bay Trail shoreline access. Use the Bay Trail in certain locations to educate the public about sea level rise, storm events, king tides, etc.
- Relocate the Bay Trail to location that addresses sea level rise and storm event impacts and maintains a high quality, Bay-focused recreation experience for trail users.

CITY OF HAYWARD

Asset Description: The City of Hayward is responsible for urban planning, building permitting, stormwater, wastewater, and surface road infrastructure, and emergency response in the study area.

The Fire Department conducts emergency preparedness and response activities for the Hayward Resilience Study area. This includes long-term disaster planning for earthquakes and other natural hazards as well as ongoing hazardous materials management and emergency response for medical and life safety issues. The City of Hayward maintains Cabot, West Winton, Depot, Enterprise, and Clawiter, paved roads that connect the commercial and industrial land uses, the Russell City Energy Center, and the Hayward Water Pollution Control Facility to the City of Hayward. Stormwater drains and pipes, owned and maintained by the City of Hayward, run throughout the study area and discharge into ACFCWCD channels. This infrastructure is funded through City of Hayward general fund and relies on the local tax base for improvements and maintenance. Decisions about infrastructure and planning are made by City Council. Hayward updated its general plan in 2014 and included sea level rise and future flood risk in its planning. This profile sheet outlines vulnerabilities and possible responses for the City of Hayward as an entire planning and management agency. For specific information on the HWPCF, West Winton Landfill, and Solar Panels, please see their respective profile sheets.

Key Issue Statement: The Hayward Resilience Study Area is vulnerable to storm future event flooding and the city will be responsible for impacts to assets it owns and manages, like the water pollution control facility, as well as private facilities and road and emergency response access to the area. Although no firehouses or other emergency response facilities are located within the study area, the City of Hayward Fire Department must consider access for emergency response. Current city plans do not take future flood risk into account and access to this area may be impaired by sea level rise and storm event impacts. Planning for sea level rise and storm event impacts will become increasingly necessary to protect the health, safety and welfare of residents, employees and visitors in the area. The city will also need to plan and fund improvements to stormwater, wastewater and transportation infrastructure in this area in light of sea level rise and storm event impacts.

Vulnerabilities

GOV: Current emergency response (planning, funding, policies, approaches, public and private standards) does not consider sea level rise. Past flooding events may not be representative future flooding events and, as a result, emergency response operations may need to change.

FUNC: Emergency responders require roads, telecom, power and similar services. If these services are disrupted by storm events and sea level rise, their ability to provide emergency services during and after flooding will be significantly compromised.

FUNC: Businesses like warehouses, office parks, and factories all rely on roads, power, water, and wastewater treatment. If these services are disrupted by storm events and sea level rise, day-to-day operations of the industrial park could be disrupted even if specific businesses are not flooded.
PHYS: Sea level rise will increase flood risk in these low-lying areas unless there are improvements to the flood control system to store increased flood flows.

Consequences

Society and Equity: Emergency services protects people where they live, work, and recreate both from day-to-day events and natural disasters. If sea level rise impairs emergency response activities, people will face increased risks at work, home, and in community spaces. The commercial and industrial land uses in the area employ City of Hayward and other regional residents. If the businesses are damaged or disrupted by sea level rise impacts, these jobs may leave the City of Hayward or the region.

Environment: If emergency and hazard mitigation plans and procedures are not updated, hazardous materials could be mobilized and impair water quality and damage local habitat.

Economy: Emergency services helps agencies, businesses, and communities prepare for, mitigate, respond to, and recover from disasters. If sea level rise impacts are not considered in emergency response planning, communities will face more damage from natural disasters and longer recovery times, both of which have negative economic effects. The commercial and industrial land uses in the area pay taxes to the City of Hayward and generate economic activity for the area. If the businesses are damaged or disrupted by sea level rise impacts, these economic benefits could be diminished or lost.

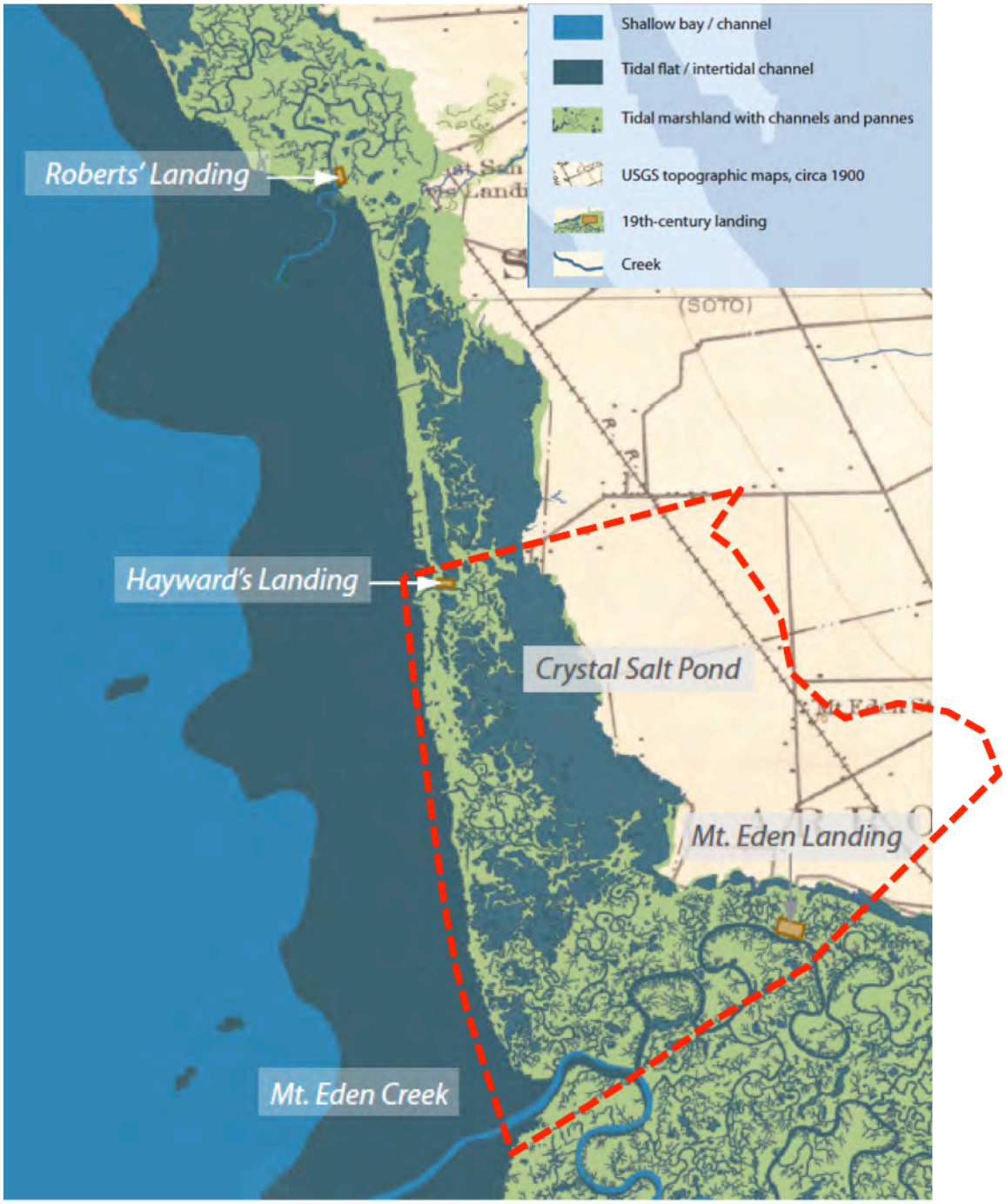
City of Hayward Proposed Adaptation Actions

- Update emergency response plans and procedures to consider how emergency response activities will continue given that many access routes and transportation modes may also be disrupted
- Provide expanded Community Emergency Response Team (CERT) trainings, refresher classes, and annual exercises that include future flood events
- Require facilities that generate, transport, and/or store hazardous materials to consider vulnerability and risks of sea level rise, storm events, and elevated groundwater in emergency plans, facility operations, and capital improvement plans
- Require that hazardous materials are stored above predicted flood levels or are protected from flood damage
- Invest in backup power and cell on wheels facilities where appropriate.
- Provide incentives for or require retrofitting using waterproof shutters, shields or doors and salt-resistant materials to reduce flood damage
- Participate in and seek to qualify for the highest possible rating of the Community Rating System of the National Flood Insurance Program to reduce flood risks and private property insurance costs.
- Maintain stormwater infrastructure and improve flood channel capacity to prevent flooding in commercial and industrial areas through a maintain-a-drain or similar program community engagement program.
- Develop an agreement with ACFCWCD that articulates shared objectives as well as maintenance and planning responsibilities for addressing sea level rise and storm event impacts on the study area.
- Develop and adopt plans for future relocation of people, uses, and services that are at risk of becoming isolated where sole or limited access ways cannot be improved or protected, and where no other alternative means of access is feasible.

COGSWELL MARSH

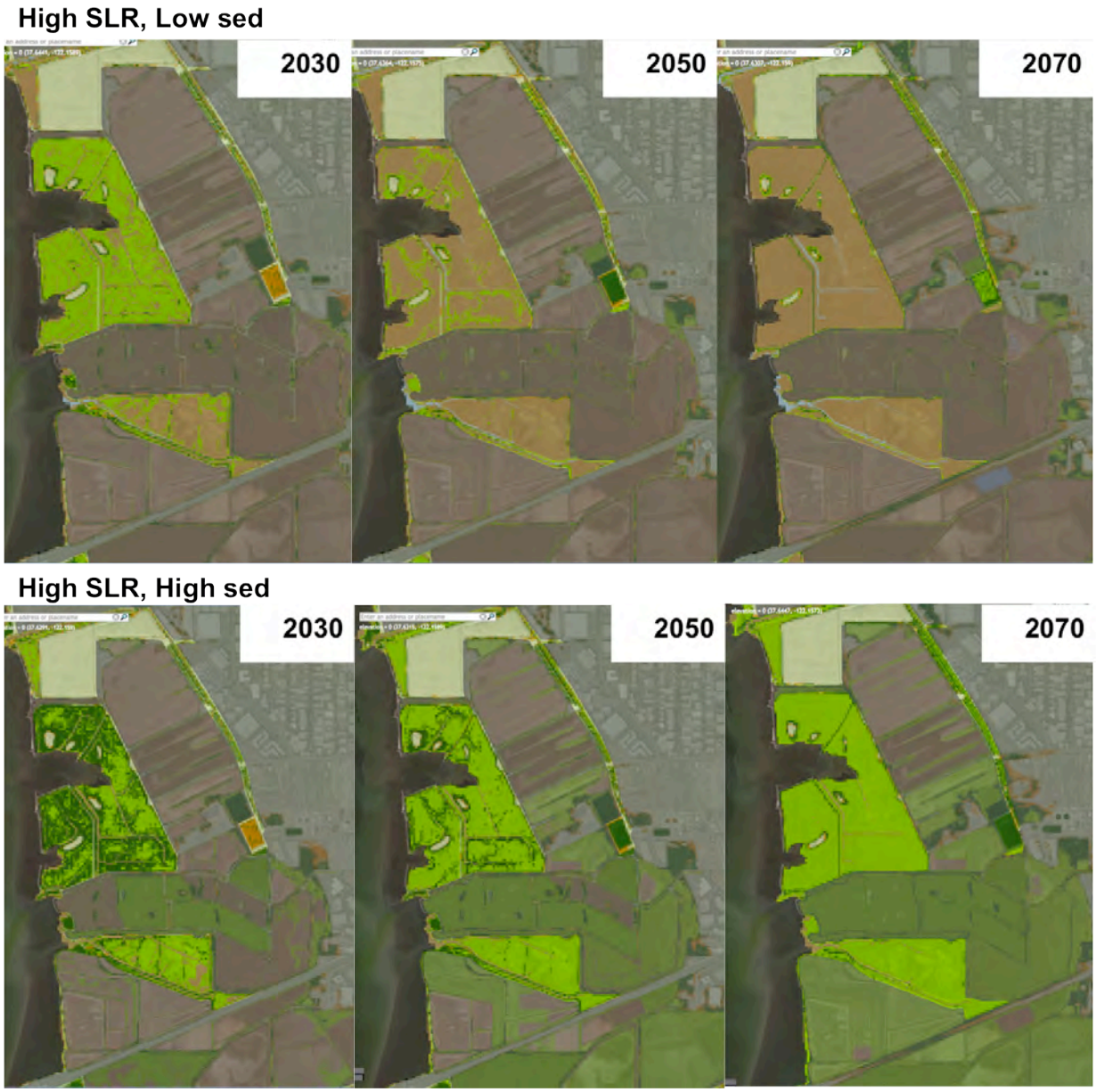
Asset Description: Cogswell Marsh is 250 acres of fully tidal and mostly low marsh habitat within the Hayward Regional Shoreline managed by East Bay Regional Parks District (EBRPD). Cogswell Marsh was restored to tidal action in 1980 and at the time, the project was one of the largest restoration projects in the region. The goal was to create tidal marsh habitat rather than manage for a particular species, and the marsh currently provides habitat for many migratory and marsh species, including the federally endangered California clapper rail. EBRPD takes a "leave it alone, unless there's a problem" approach to marsh management. There is no written management plan and no major changes to the marsh are planned.

The history of Cogswell Marsh demonstrates how the area is naturally low-lying and subject to wave action. Historical records show Cogswell Marsh was part of a broad, contiguous tidal marshland with extensive sloughs. Wave action build up sandy berms that prevented tidal drainage in places, allowing large natural salt ponds to form, including Crystal Salt Pond. Maps from the mid-1800s also indicate that the shoreline has eroded approximately 500 feet to its present location. As Hayward grew steadily throughout the late 1800s, the area was diked for commercial salt production, which continued until the mid-1940s. The area was seasonal wetland until the outboard berms were breached in 1980. The marsh restoration project was funded by Caltrans as compensation/mitigation for wetland impacts anticipated in construction of the Dumbarton Bridge. Site elevations were lowered, nesting islands were constructed, and channels were excavated to facilitate tidal exchange. Tidal marsh vegetation established slowly and the restoration community learned from this early project. Decades later, some of this vegetation (non-native cordgrass) was removed through the Invasive Spartina Project Eradication Program, which decreased California clapper rail habitat and increased wave erosion within the channels.



Historical map circa 1850 showing Hayward Resilience Study area in red dashed line. (Image adapted from San Francisco Estuary Institute http://www.sfei.org/sites/default/files/05SOE_historical_sideB_MedRes.pdf).

Map of Hayward Resilience Study area showing current tidal and managed marsh and pond habitats (http://data.prbo.org/apps/sfbslr/).



Map of study area showing future tidal marshes based on modeling results for a high sea level rise rate (65 inches between 2010 and 2110) and low and high sediment supply (100 and 150 mg/L, respectively) in 2030, 2050, and 2070 (http://data.prbo.org/apps/sfbslr/). The high sea level rise rate is shown given observed greenhouse gas emissions are exceeding climate change model emission scenarios. While current sediment supply is unknown, the 2030 elevations under the high sediment scenario are higher than current elevations. Since sediment concentrations in the Bay are declining, the low sediment supply may be closer to natural conditions. However, the contrast in low and high sediment supply results illustrates the potential benefits of local sediment management. Results for managed marshes and ponds have been greyed out because the model is intended for fully tidal systems, e.g., no tide gates.

Key Issue Statement: Sea level rise will increase the depth, duration, and frequency that Cogswell Marsh is flooded and the marsh is predicted to drown around mid-century, if no actions are taken. Cogswell Marsh could build upward or move landward to counteract this flooding. However, the available sediment supply appears low and since the marsh is backed by a steep inboard levee/access road and the adjacent land is already being used by the Hayward Water Pollution Control Facility (HWPCF) to store wet weather flows

(within the oxidation ponds), there is no room to migrate landward to avoid being squeezed against steep levees by a rising Bay. Cogswell Marsh is approximately 2,300 feet wide and studies show that approximately 1,000 feet of tidal marsh can reduce wave height and energy associated with extreme storm events by over 50%, where increased width increases the natural flood protection benefits and decreases the necessary height of the inland levee. The wildlife habitat and flood protection benefits that Cogswell Marsh provides will not be sustained if the marsh becomes mudflat.

Vulnerabilities

INFO: While future sediment supply is unknowable, site-specific information on current available sediment supply to Cogswell Marsh would improve our understanding of its resilience to sea level rise.

GOV: While the 2013 EBRPD Master Plan states its commitment to the protection of tidal marsh habitat, there is not yet a long-term strategy to improve the resilience of marsh habitat as sea level rises. EBRPD has not engaged with resource agencies to explore the significance of specific marshes within the Hayward Regional Shoreline in context to overall marsh restoration and enhancement priorities in the region. This kind of long-term planning is needed to inform and ultimately permit possible interventions in existing marshes to maintain wildlife populations.

FUNC: Cogswell Marsh provides wildlife habitat and flood protection benefits to the HWPCF and Russell City Energy Center that will not be sustained if the marsh downshifts to low marsh or mudflat.

PHYS1: Mudflats buffer Cogswell Marsh and its outboard levees from wave erosion. Sea level rise will decrease this natural shoreline protection because less wave height reduction occurs in deeper water, resulting in increased erosion of the interior of Cogswell Marsh and its outboard levees.

PHYS2: Cogswell Marsh is fully tidal and mostly low marsh, but habitat change models predict the marsh will drown around midcentury (depending on sea level rise and sediment supply).

PHYS3: Cogswell Marsh is backed by the HWPCF former oxidation ponds, which are currently used to store wet weather flows. Without grading or land use changes, there is not enough elevation capital for the marsh to migrate landward to avoid being squeezed and drowned by a rising Bay.

Consequences

Society and Equity: People enjoy the views of the marsh and the species within it and the loss of the marsh would reduce recreational and educational value.

Environment: Cogswell Marsh provides good tidal marsh habitat for species such as federally endangered California clapper rail. Storm event flooding makes these species more vulnerable to predation and can reduce reproductive success if nests are flooded. Downshifting habitat means marshes will be flooded more often, exacerbating these population stresses, until conversion of marsh to mudflat results in complete loss of tidal marsh species at this marsh.

Economy: Cogswell Marsh is the first line of defense against coastal flooding of commercial and industrial area including the HWPCF. Rebuilding the HWPCF to current codes and standards could cost approximately $500 million.

EBRPD Proposed Adaptation Actions

- Partner with HARD to engage resource managers and agencies, particularly the South Bay Salt

Pond Restoration Project and California Department of Fish and Wildlife, to articulate shared goals, decision-making, and funding responsibilities for addressing sea level rise and storm event impacts on tidal marshes and managed ponds in the Hayward Regional Shoreline.

- Based on meeting outcomes, develop a marsh sea level rise adaptation strategy, form partnerships to monitor and identify when the marsh is approaching thresholds for possible interventions, and conduct hydrologic, geomorphic, and ecological analyses to determine the feasibility of possible interventions, e.g., coarse beaches to decrease marsh edge erosion and mudflat/marsh recharge or rainbowing to increase sedimentation on the marsh plain.
- Partner with City of Hayward, EBRPD, HARD, and EBDA to investigate opportunities for long-term, coordinated, multi-benefit shoreline protection approaches that would maintain or create marsh habitat, improve flood control capacity in Zone 4, protect inland commercial and industrial areas from flooding, and reuse treated wastewater.

EAST BAY DISCHARGERS AUTHORITY (EBDA)

Asset Description: EBDA was formed in 1974 as a joint powers authority (JPA). EBDA provides wastewater disposal services to its five member agencies – the cities of San Leandro and Hayward, and the Union, Oro Loma and Castro Valley Sanitary Districts – serving a population of approximately 800,000. Through a separate agreement, EBDA also provides disposal services to the Livermore-Amador Valley Water Management Agency (LAVWMA), which consists of the City of Livermore and the Dublin-San Ramon Sanitary District. Treated wastewater from these agencies is conveyed though a system of pipes and pumps to the EBDA Marina Dechlorination Facility, where residual chlorine is removed to reduce toxicity prior to being discharged via the EBDA Bay Outfall and Diffuser.

Each member agency is allowed to discharge to the EBDA system an amount of wastewater based on its capacity allowance. The Bay Outfall and Diffuser was built in 1978 – the outfall extends approximately seven miles into the Bay, with the last 2,000 feet being a diffuser section designed to ensure maximum dilution and mixing with deep Bay waters. The Bay Outfall and Diffuser can convey 189.1 million gallons per day (MGD). The system can convey average dry weather flows, but depending upon timing from individual watersheds, cannot accommodate all peak flows from its EBDA members and LAVWMA. During extreme wet weather events, Union Sanitary District discharges excess flow to Hayward Marsh and LAVWMA to San Lorenzo Creek. During a 25-yr storm event in 1998, the Bay Outfall and Diffuser capacity proved to be a bottleneck, forcing the City of San Leandro and the Oro Loma Sanitation District to use their wet weather bypass overflow weirs, where dechlorinated secondary-treated effluent was discharged directly to the Bay.

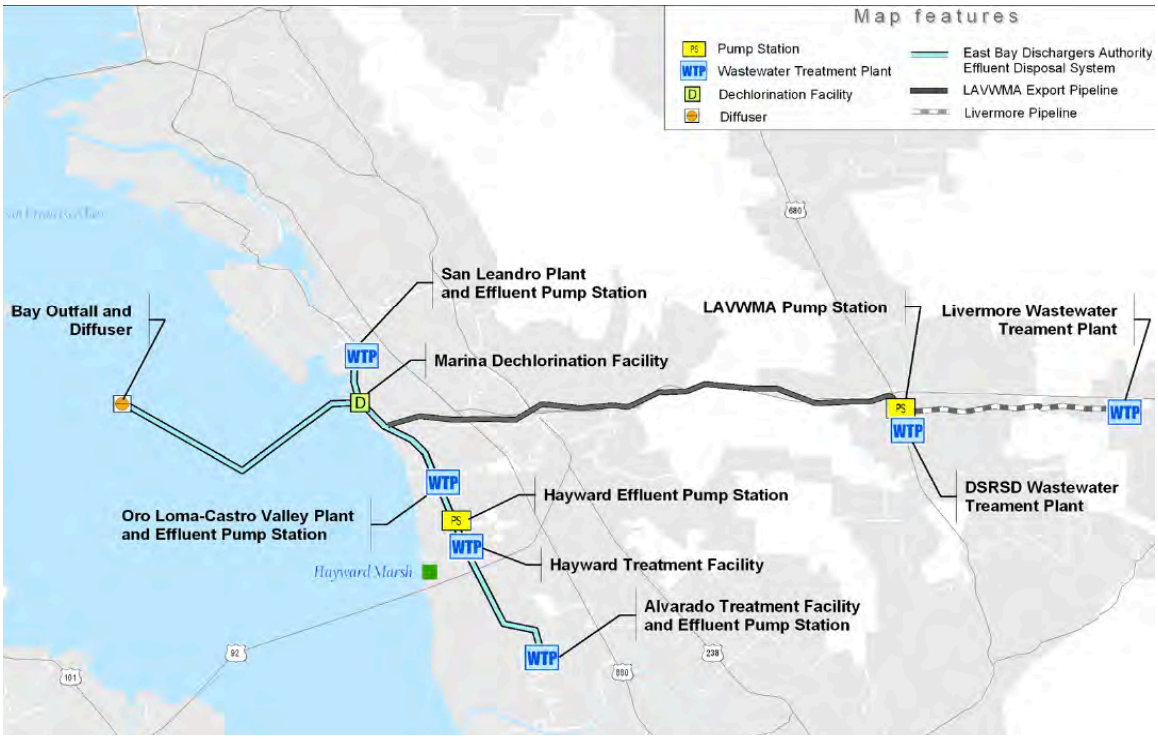


Diagram of EBDA system.

The expected life of the existing EBDA pipeline is to around mid-century. EBDA is currently conducting a system assessment to investigate the condition of its infrastructure and begin planning for long-term changes to the system, including increasingly stringent regulations to control nitrogen from wastewater effluent. Additional nutrient removal processes tend to produce greenhouse gases and have high energy requirements (Harris-Lovett 2014). As an alternative to upgrading and maintaining a centralized system, EBDA secured a Climate Ready Grant and is investigating decentralized alternative treatment and discharge through the local wetlands that would have multiple benefits including, protecting facilities from sea level rise, removing critical infrastructure out of the hazard zone, and increasing the reuse of treated wastewater, for example to enhance wetlands.

Key Issue Statement: The EBDA system consists of aging infrastructure and increasing challenges regarding nutrient loading. This system already has limited capacity to discharge wet weather flows from its members and LAVWMA. Capacity is further reduced during high storm tides by as much as 10 MGD. Sea level rise and storm events will exacerbate this existing issue, resulting in more frequent and potentially longer lasting occurrences when discharge capacity is limited.

Vulnerabilities

GOV1: Since EBDA is a JPA, the system is jointly owned and managed. While a JPA provides a framework for joint decision-making, it could complicate planning and funding decisions to address sea level rise and future storm event challenges.

GOV2: The EBDA pipeline runs through natural shoreline systems including tidal marshes and managed ponds. Work on the pipeline requires regulatory review from a number of resource agencies, which can be a lengthy and difficult process.

FUNC: Sea level rise will progressively reduce Bay Outfall and Diffuser capacity and exacerbate wet weather flow capacity issues. The discharge capacity of the Bay Outfall and Diffuser is reduced by as much as 10 MGD during existing high storm tides, which will occur more often as sea level rises because today's high storm tides will be the future's daily high tide. The reduced capacity will have consequences on how each member agency handles wet weather flows and will threaten the overall performance of the EBDA system.

PHYS: The EBDA pipeline runs through predominantly low soil strength bay muds and is subject to a high groundwater table because of its proximity to San Francisco Bay. Rising groundwater increases the potential for the EBDA pipeline to float, making it susceptible to damage that will increase the need for maintenance, repair, and replacement.

Consequences

Society and Equity: EBDA provides a critical public health and safety function. If storm events or sea level rise overwhelm and compromise the system, it could affect member agencies ability to treat and discharge wastewater.

Environment: If storm events or sea level rise overwhelm and compromise the system, secondary-treated and possibly chlorinated effluent could overflow into the environment. Toxic substances and excessive nutrients degrade water quality and harm fish and other aquatic organisms. Failure to dechlorinate effluent prior to discharge may impact sensitive habitat or endangered species depending on the amount and location of the overflow.

Economy: Since the EBDA system serves the communities of San Leandro, Hayward, Union City, Newark,

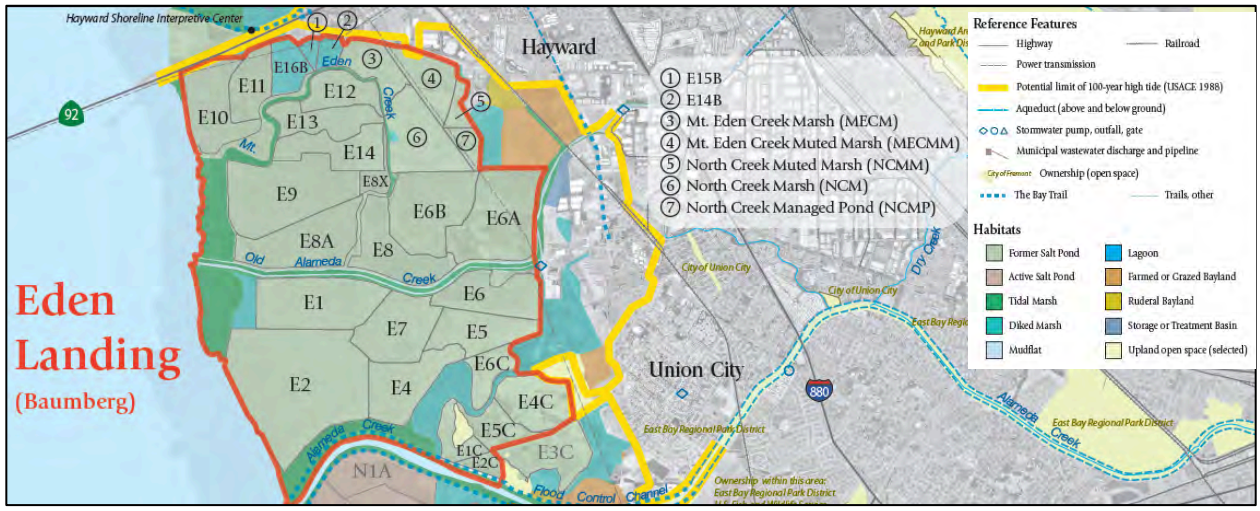
Fremont, Pleasanton, Dublin, and Livermore, system disruption could potentially have wide-ranging consequences depending on the type and duration of the disruption. Cumulative impacts on commercial and industrial businesses and the associated employment, goods, and services they provide could also be significant. Furthermore, the estimated cost of upgrading the current EBDA system to maintain centralized wastewater discharge is $0.5 – 1 billion.

EBDA Proposed Adaptation Actions

- Complete a system-wide assessment on infrastructure condition.
- Complete study on decentralized alternatives to existing wastewater treatment and discharge practices incorporating stakeholder and expert input and technical review.
- Based on study results, conduct further feasibility analysis on select concepts and strategies.
- Based on feasibility analysis, plan for the future EBDA system as centralized or decentralized wastewater treatment and discharge and partner with EBRPD, HARD, ACFCWCD, the City of Hayward, and South Bay Salt Ponds Restoration Project to investigate opportunities for long-term, coordinated, multi-benefit shoreline protection approaches.

EDEN LANDING ECOLOGICAL RESERVE

Asset Description: The California Coastal Conservancy (CCC) and California Department of Fish and Wildlife (CADFW) manage and own approximately 5,450 acres of Eden Landing that is part of the South Bay Salt Pond Restoration Project, which began implementation in 2008 and has a 50-year planning horizon. The portion of Eden Landing within the Hayward Resilience Study area is north of Mt. Eden Creek, including managed ponds (E10, E11, E14B, E15B, and E16B) and part of Baumberg Tract tidal marsh. While no restoration is currently planned in this area, adaptive management is an integral component of the South Bay Salt Pond Restoration Project and includes a framework to evaluate whether managed ponds should be abandoned and converted to other (likely tidal) habitat types over time, depending on their elevation, location in the Bay, and the need for specific habitat types from wildlife populations at risk. These large natural areas have the potential to be resilient to sea level rise. The ultimate mix of tidal marsh and managed pond habitats will likely be between 50:50 and 90:10 depending on lessons learned from earlier phases. Phase 2 planning is currently underway.



Map of Eden Landing managed ponds and tidal marshes (http://www.southbayrestoration.org/maps/#detailed).

Key Issue Statement: Sea level rise will put increasing pressure on pond infrastructure and may cause marsh drowning in Baumberg Tract around midcentury, which is within the 50-year planning horizon of the South Bay Salt Pond Restoration Project. While the project takes sea level rise into account, there is no long-term funding strategy. Furthermore, balancing habitat needs for threatened and endangered species, while also providing the same level of flood protection and improving public access and recreation is challenging because these goals are highly regulated and may conflict at times. Sea level rise may exacerbate existing regulatory requirements and constrain the possible adaptation actions that can be taken. Wildlife habitat, flood protection, and public access benefits will not be sustained if managed ponds are overtopped and marsh downshifts to mudflat.

Vulnerabilities

GOV1: Eden Landing has multiple objectives: wildlife habitat, flood protection, and public access and recreation, requiring a complex permitting process (e.g. multiple applications and contingent rather than parallel reviews related to USACE Section 404 permit, Endangered Species Act Section 7 consultation with USFWS and NOAA, BCDC permit, RWQCB Section 401 certification). The result is often a lengthy permit process, which can jeopardize funding and opportunities for available resources such as sediment. Monitoring data required by regulatory agencies is not leveraged to streamline the process, e.g., to develop best practices and adaptive management guidelines. The lack of efficient and flexible permitting makes implementation of large-scale restoration difficult to achieve.

GOV2: The second and future phases of the South Bay Salt Pond Restoration Project at Eden Landing do not have clear funding sources for either implementation or monitoring/adaptive management.

FUNC: Eden Landing provides extensive wildlife habitat, flood protection, and public access and recreation benefits that will not be sustained if managed ponds are overtopped and marsh converts to mudflat.

PHYS1: Threatened and endangered species within Eden Landing managed ponds require particular water levels and sea level rise will put pressure on the existing system of levees, water control structures, and drainage operations, and may require new management practices, e.g., ponds that are currently gravity-fed may become reliant on pumping.

PHYS2: Baumberg Tract is fully tidal and already contains large interior mudflat areas. Habitat change models predict the marsh will drown by midcentury (depending on sea level rise and sediment supply).

PHYS3: Baumberg Tract is backed by industrial/residential development. Unless this land use changes, there is not space for the marsh to migrate landward and avoid being squeezed and drowned by a rising Bay.

Consequences

Society and Equity: People enjoy the views of Eden Landing from the Bay Trail and SR-92 and the loss of these areas would reduce recreational and educational value.

Environment: Eden Landing provides both tidal marsh and pond habitat for threatened and endangered species. For example, the largest concentration of breeding and wintering snowy plovers in the Bay is located in the Eden Landing ponds. It is also an important migratory stopover for Pacific Flyway species. Loss of control of water levels in managed ponds would result in habitat loss and the impact on the species depends on whether there are viable alternative habitats. There are also consequences of sea level rise and storm event impacts on tidal marshes. Storm event flooding makes tidal marsh species more vulnerable to predation and can reduce reproductive success if nests are flooded. As sea level rises, marshes will be flooded more often, further exacerbating population stresses.

Economy: Eden Landing is the first line of defense against coastal flooding of the Glen Eden neighborhood. These natural flood protection benefits were explicitly considered during restoration design and the existing structural shorelines would not be sufficient to protect against extreme storm events (e.g., the 100-year storm) without Eden Landing.

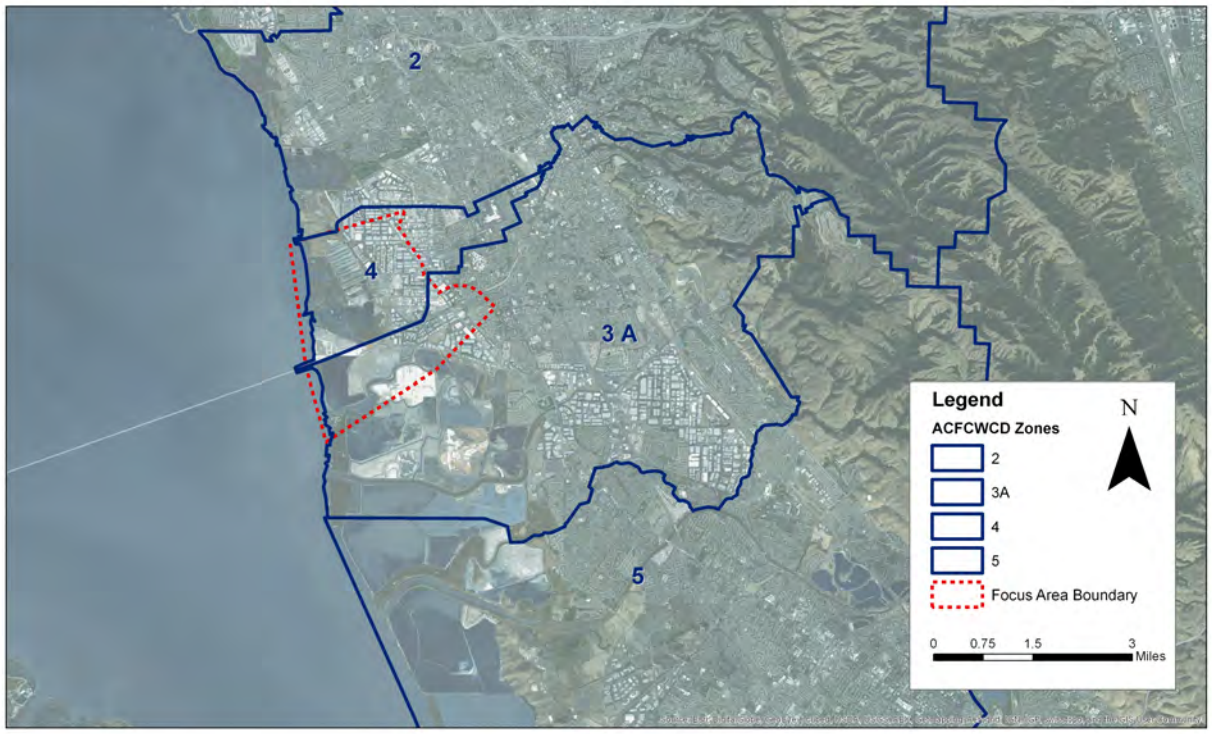
CADFW and CCC Proposed Adaptation Actions

- CADFW continues to perform routine levee and water control structure maintenance to improve the resilience of managed ponds.

- The South Bay Salt Pond Restoration Project continues to support efforts to improve coordination among agencies and stakeholders to research, test, and disseminate lessons learned from innovative sea level rise adaptation actions.
- The South Bay Salt Pond Restoration Project continues to secure funds through local partnerships, private sector participation, and regional, state and federal grants for monitoring/adaptive management.
- Partner with City of Hayward, ACFCWCD, EBRPD, HARD, and EBDA to investigate opportunities for long-term, coordinated, multi-benefit shoreline protection approaches for the second half of the century that would maintain or create marsh habitat, improve flood control capacity, protect inland development from flooding, and reuse treated wastewater.

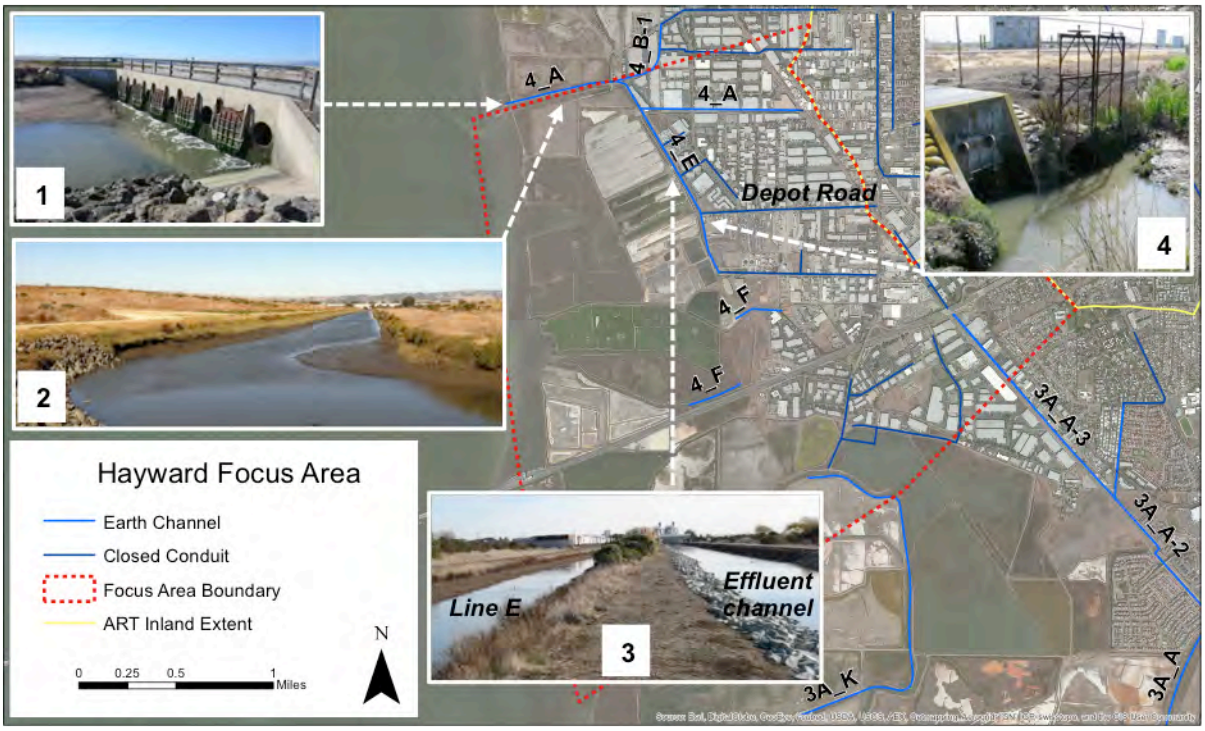
FLOOD CONTROL (Zone 4 Lines A and E)

Asset Description: The Hayward Resilience Study area is within Alameda County Flood Control Water Conservation District (ACFCWCD) Zone 4, a 4.6 square-mile zone extending from the base of the San Leandro Hills to the Bay. Zone 4 serves a portion of the City of Hayward, Mohrland, and Russell City.



Map of ACFCWCD zones showing the study area north of the Hayward-San Mateo Bridge within Zone 4, which is smaller than surrounding zones and does not include upper watershed area.

There are two main flood control channels within the study area – Lines A and E, which rely on gravity drainage to discharge rainfall-generated runoff. Line E runs parallel to the shoreline along the Hayward Water Pollution Control Facility and then makes a sharp 90-degree turn at West Winton Ave. to join Line A, which drains to the Bay. Prior to the creation of the East Bay Discharge Authority's centralized wastewater treatment and discharge system in 1970s, Lines A and E conveyed treated wastewater to the Bay and therefore have design capacity beyond what is required for flood management. Preliminary results of FEMA's San Francisco Bay Area Coastal Study indicate that the Line E is outside of the coastal Special Flood Hazard Area (SFHA). During high tides, Bay water can fill Line E and enter into the stormwater drainage system that serves adjacent commercial and industrial areas. These back-ups have not caused flooding in the industrial areas to date.



Map and photographs of the flood control system (all looking upstream): 1) Outfall structure at the Bay; 2) Line A channel extending from the Bay to the confluence with Line E; 3) Line E channel adjacent to commercial and industrial area and the Hayward Water Pollution Control Facility effluent channel (on the bayward side); and 4) water control structures at Depot Road.

Several water control structures control tidal action in Lines A and E. An outfall structure at the confluence of Line A and the Bay allows high tides to enter the channel through the open upper openings, while water exits during low tides through lower openings that have flap gates (photo 1 above). This design was intended to minimize sedimentation in the channel and thereby maintain flow capacity. ACFCWCD has dredged the channel a few times since its construction in 1955, but not in the last 15 years or so. At the intersection of Line E and Depot Road, which is upstream boundary of the average high tide ('head of tide'), there are two additional water control structures (photo 4 above). The larger structure with a single opening was installed by ACFCWCD in 1970 to prevent tides from flowing further upstream along Depot Road. The two smaller openings allow water to cross under Depot Road and, if tides are high enough, water flows in Line E along the Hayward Water Pollution Control Facility. It is believed these smaller openings were used when Line E conveyed treated wastewater treatment. As this is no longer the case, the Hayward Pollution Control Facility does not manage these tide gates and it is unclear which agency is responsible for their maintenance.

Key Issue Statement: Tidal action currently extends through Lines A and E to Depot Road. Although the flood control channels have capacity for today's storm events, they do not have capacity for future sea level rise and storm events, which could cause flooding along the Bay Trail adjacent to Line A and in the commercial and industrial areas adjacent to Line E. As sea level rises, more Bay water will fill these channels and where this additional water will flow depends on how the water control structures at Depot Road are managed. For example, if the larger opening is closed and the smaller openings are open, water may flow underneath Depot Road in Line E along the Hayward Water Pollution Control Facility, whereas if all of these openings are closed, water flow overbank or backup into the stormwater drainage system for the adjacent commercial and industrial area. This increased tidal action reduces the capacity of the flood control channels

to discharge rainfall-generated runoff, particularly when rainfall events coincide with high tides. More detailed analysis is needed to understand the thresholds that cause backups and flooding. Finally, existing restrictions on how flood control improvements are funded due to Proposition 218 will pose challenges to funding the improvements that are necessary to address sea level rise and storm events, unless these restrictions are alleviated or new revenue sources are identified.

Vulnerabilities

INFO: ACFCWCD has studies, designs, maintenance logs, and permit information on its flood control assets, but the information is not publicly available and is difficult to access and interpret.

GOV1: Since Proposition 218 passed in 1996 requiring voter approval for increased rates or new fees to fund flood control improvements, it has been more challenging for ACFCWCD to raise funds for improvements. Each year, the District undertakes a number of large and small projects to maintain infrastructure, reduce flooding, and preserve the environment. The District funds projects on a pay-as-you-go basis. Revenue sources include property taxes, state and federal grants, and land-based benefit assessment subject to Proposition 218 requirements, which have not increased since the 1990s.

GOV2: Although ACFCWCD manages and maintains flood control infrastructure in Zone 4, the risk of flooding also depends on overall conditions in the contributing watershed. Entities such as the City of Hayward and Caltrans are responsible for the storm drains and land use decisions that affect runoff in Zone 4.

FUNC: Sea level rise and storm events will reduce flood control channel capacity, making it more difficult to discharge rainfall-generated runoff as intended, particularly when rainfall events coincide with high tides.

PHYS: Flood control channels were not designed for future sea level rise and storm events and therefore the levees are not high enough to contain peak flows and higher Bay water levels. These levees were also not designed as coastal flood protection for the adjacent development and, since Line E is parallel to the shoreline, it will be exposed to higher Bay water levels along the entire length of the channel.

Consequences

Society and Equity: While more detailed analysis is needed to understand combined riverine-tidal flooding, levee overtopping along the Bay Trail would result in lost recreation and back-ups into commercial and industrial areas would affect people where they work. Furthermore, since flood control channels discharge untreated stormwater flows, flooding often releases pollutants, e.g., trash, motor oil, and pesticides, raising public health and safety concerns.

Environment: There are minimal flooding consequences to the environment since Lines A and E are primarily adjacent to development (landfills, oxidation ponds, commercial and industrial land use).

Economy: Flooding of development adjacent to Lines A and E would affect the local economy through property damage and business disruptions.

ACFCWCD Proposed Adaptation Actions

- Participate in collaborative regional discussions related to both regional and local scales, that include representatives from FEMA, USACE, BCDC, among others, to facilitate planning for future sea level rise and storm events by sharing technical knowledge on forecasting/modeling, discussing funding

strategies for improvement projects, and identifying possible regulatory challenges and solutions for flood control improvement projects.

- Conduct Zone 4 drainage study to investigate how higher Bay water levels associated with future sea level rise and storm events reduce stormwater discharge capacity either through City of Hayward stormwater system or ACFCWCD flood control channels.
- Based on drainage study findings, analyze alternatives to maintain stormwater discharge, e.g. installing pumps, modifying operation of the Bay outfall structure on Line A to prevent incoming tides from reducing channel capacity, increase channel capacity, designing low impact development retrofits in commercial and industrial areas to reduce peak flows, and land acquisition to create flood storage facilities.
- Based on alternatives analysis, secure funding and permits for implementation of multi-benefit projects that improve stormwater discharge and flood control.
- Develop a data management system to facilitate the sharing of critical asset information, e.g., channel design and capacity, current head of tide location, and water control structure locations and maintenance/operations, with partner agencies and organizations that are engaged in adaptation planning.
- Partner with City of Hayward, EBRPD, HARD, and EBDA to investigate opportunities for long-term, coordinated, multi-benefit shoreline protection approaches that would maintain or improve flood control capacity in Zone 4, protect inland commercial and industrial areas from flooding, create habitat, and reuse treated wastewater.

HARD MARSH

Asset Description: HARD Marsh is 79 acres of fully tidal low marsh with large interior mudflat areas within the Hayward Regional Shoreline managed by the Hayward Area Recreation District (HARD). When HARD opened the Hayward Shoreline Interpretive Center (HSIC) in 1986, it began planning the restoration of HARD Marsh, which was formerly a duck club. The marsh was first restored to muted tidal action and later restored to full tidal action because more flushing was needed to reduce nuisance odors associated with the HSIC's location perched on stilts above tidal marsh near the back of HARD Marsh. While this increase in tidal action caused unintended flooding of the Oliver Salt Ponds, no major changes to HARD Marsh are planned.

Key Issue Statement: Sea level rise will increase the depth, duration, and frequency that HARD Marsh is flooded and the marsh is predicted to drown around mid-century, if no actions are taken. HARD Marsh could build upward or move landward to counteract this flooding. However, water flows in and out of the marsh through a tidal channel that passes under a pedestrian bridge, and sea level rise may change the hydraulics and sediment dynamics in this constrained system. HARD Marsh also does not include any islands or other forms of high ground upon which it could migrate as sea level rises, as it is backed by the Salt Marsh Harvest Mouse Preserve. Since the Hayward Shoreline Interpretive Center relies on the HARD Marsh for its education program, the center may need to change its program if the marsh downshifts from low marsh to mudflat.

Vulnerabilities

INFO: While future sediment supply is unknowable, site-specific information on current available sediment supply to HARD Marsh would improve our understanding of its resilience to sea level rise.

FUNC: HARD Marsh provides unique educational value for the Hayward Shoreline Interpretive Center as well as wildlife habitat and flood protection benefits that will not be sustained if the marsh converts to mudflat.

PHYS1: Water flows in and out of the marsh through a tidal channel that passes under a pedestrian bridge, and sea level rise may change the hydraulics and sediment dynamics in this constrained system. The pedestrian bridge has already been repaired twice to address scour, and its footings continue to erode due to wave action. Sea level rise may increase scour around the bridge footings due to increased tidal prism.

PHYS2: HARD Marsh is fully tidal and already contains large interior mudflat areas. Habitat change models predict the marsh will drown by midcentury (depending on sea level rise and sediment supply).

PHYS3: The HARD Marsh is bordered by a steep inboard levee/access road, which separates HARD Marsh from the adjacent Salt Marsh Harvest Mouse Preserve. Since neither the levee/road nor the Salt Marsh Harvest Mouse Preserve offer high ground upon which the HARD Marsh could migrate as sea level rises, HARD marsh is vulnerable to being squeezed and drowned by a rising Bay.

Consequences

Society and Equity: HARD Marsh provides educational value for the Hayward Shoreline Interpretive Center and the loss of the marsh would result in a loss of educational and recreational opportunities in the region and require changes to the educational program of the Hayward Shoreline Interpretive Center.

Environment: HARD Marsh provides some tidal marsh habitat and storm event flooding makes these species more vulnerable to predation, especially because there is already very limited high tide refugia.

Economy: HARD Marsh is part of the flood protection of the industrial development behind the Salt Marsh

Harvest Mouse Preserve. If this flood protection is lost, property damage and service disruptions in the industrial and commercials would lead to local economic damage due to recovery costs and lost productivity.

HARD Proposed Adaptation Actions

- Determine feasibility of updating existing management plans to factor in storm events and sea level rise, e.g., perform routine inspections of the bridge footings and sediment erosion/deposition patterns at the inlet because this is the marsh's connection to Bay sediment that is needed to keep pace with sea level rise.
- Partner with EBRPD to engage resource managers and agencies, particularly the South Bay Salt Pond Restoration Project and California Department of Fish and Wildlife, to articulate shared goals, decision-making, and funding responsibilities for addressing sea level rise and storm event impacts on tidal marshes and managed ponds in the Hayward Regional Shoreline and maintaining environmental education in the region.
- Based on meeting outcomes, develop a marsh sea level rise adaptation strategy, form partnerships to monitor and identify when the marsh is approaching thresholds for possible interventions, and conduct hydrologic, geomorphic, and ecological analyses to determine the feasibility of possible interventions, e.g., islands to create high tide refugia and mudflat/marsh recharge or rainbowing to increase sedimentation on the marsh plain.
- Partner with City of Hayward, ACFCWCD, EBRPD, and EBDA to investigate opportunities for long-term, coordinated, multi-benefit shoreline protection approaches that would maintain or create marsh habitat, improve flood control capacity in Zone 4, protect inland commercial and industrial areas from flooding, and reuse treated wastewater.

HAYWARD MARSH

Asset Description: Hayward Marsh is a 145-acre, five-basin managed pond system built in 1985 that receives secondary treated wastewater from Union Sanitary District's (USD) Alvarado Wastewater Treatment Plant (serving 334,600 people and businesses in Fremont, Newark, and Union City). East Bay Regional Parks District (EBRPD) owns the marsh and maintains the levees/berms, valves/weirs, channels and islands, while USD provides freshwater inflow. USD, EBRPD, and East Bay Dischargers Authority (EBDA) are joint holders of the National Pollutant Discharge Elimination System (NPDES) permit from the Regional Water Quality Control Board. Since 1988, USD has discharged between 3 and 5 million gallons per day (MGD) of secondarily treated final effluent, or 10 - 15% of USD's average flows, from the EBDA pipeline to Hayward Marsh. In addition, Hayward Marsh can take up to 20 MGD from USD during wet weather flows, when there is not capacity in the EBDA pipeline. Freshwater effluent creates a salinity gradient that is unique along the Hayward Regional Shoreline and the resulting brackish pond habitat includes islands created as predator refugia for nesting threatened and endangered species, e.g., one of the few successful California least tern colonies in the Bay is in basin 3A.

Map of Hayward Marsh showing specific ponds and channels under investigation (prepared by RMC Water and Environment as part of Hayward Marsh Rehabilitation Options Study). Basins 1, 2A, and 2B are freshwater ponds, while basins 3A and 3B are brackish ponds. Tidal waters are designed to mix in Basins 3A and 3B, but not Basins 1, 2A, and 2B. The outboard levee along basin 3B is part of the Bay Trail.

EBRPD and USD are currently exploring options to rehabilitate Hayward Marsh. Bay water no longer can flow into basin 3B because the mixing channel and culvert that allows inflow are full of sediment. Since the dredging project is beyond EBRPD capacity, USD agreed to assist in conducting a feasibility study to evaluate a range of options including full rehabilitation of Hayward Marsh to maintain status quo operations; partial rehabilitation of Hayward Marsh to maintain freshwater flow and restore basins 3A or B to seasonal wetland; repurpose basin 1 for wet weather storage en route to EBDA pipeline, while closing basins 2A and B and restoring basins 3A and/or B to tidal wetland (change the topography and open up to the Bay); and abandon Hayward Marsh, while USD invests in other wet weather storage solutions, including use of the City of Hayward Water Pollution Control Facility oxidation ponds. All of these options consider sea level rise. To date, the most significant constraint is cost. A decision regarding which option to pursue and how is expected by the end of 2014. As implementation will be phased, this decision will set the trajectory for management and maintenance of Hayward Marsh for the next 20 to 30 years.

Key Issue Statement: Hayward Marsh has multiple management objectives related to water quality and threatened and endangered species, requiring a complex permitting process to maintain the system and perform improvements. Hayward Marsh relies on levees and tide gates to manage water levels and sea level rise will make it increasingly difficult to maintain these levels, resulting in progressively more ponding and worse drainage. As water levels change and topography doesn't, the inundation regime and hence the habitats and species therein will inevitably change. Current regulatory requirements may constrain possible adaptation actions. Furthermore, financing concerns about current rehabilitation options underscore the need for a clear funding source to maintain the system.

Vulnerabilities

GOV1: Hayward Marsh has multiple management objectives a) polishing wastewater, b) providing freshwater for brackish, managed pond habitat for species like least terns, and c) accommodating USD wet weather flows. These objectives are challenging to achieve simultaneously and all three are tightly regulated by natural resource agencies (e.g. Endangered Species Act Section 7 consultation with USFWS and NMFS, and RWQCB NPDES permit). Sea level rise will introduce new water quality, habitat, and species concerns, further stressing an already tightly managed system.

GOV2: No dredging of the mixing channel has occurred since the initial construction in 1985 and the cost of dredging to restore tidal circulation has stalled efforts to restore system function. The lack of a clear funding source is a critical current and future problem since sea level rise will make it increasingly difficult to manage water levels and sedimentation, e.g., new levees and tide gates will needed.

FUNC: Hayward Marsh provides wildlife habitat, water quality, and flood protection benefits that will not be sustained if the managed ponds are overtopped.

PHYS1: The outboard levees along the Hayward Marsh are in need of repair and sea level rise will increase wave erosion and the need for increased crest height, more armoring, and continued maintenance. Mudflats in deeper water provide less wave height reduction, which will increase fringing marsh erosion. At Johnson's Landing, marsh is currently retreating landward at a rate of approximately three feet per year.

PHYS2: Hayward Marsh is a series of managed ponds and the threatened and endangered species within them require particular water levels managed by tide gates and levees, e.g., California least terns would be unable to nest if islands were flooded by higher water levels. Sea level rise will put pressure on these tide gates and levees because they represent fixed topography.

Consequences

Society and Equity: While Hayward Marsh is behind fences and closed to the public to protect nesting areas, it provides a public health and safety function by accommodating USD wet weather flows.

Environment: Since Hayward Marsh is one of few successful nesting colonies for the endangered California least tern in the Bay, loss of this habitat would be particularly significant for the regional population. Hayward Marsh is also an important migratory stopover for Pacific Flyway species and offers a unique salinity transition for species like rearing Bay fish.

Economy: The Hayward Marsh accommodates wet weather flows from USD. Without Hayward Marsh, USD would have to invest in other solutions.

EBRPD and USD Proposed Adaptation Actions

- EBRPD and USD can continue to work together to evaluate rehabilitation options commensurate with sea level rise during life of the project and update the management plan accordingly; depending on the selected option, identify funding sources for project implementation and maintenance.
- USD can continue to coordinate with EBDA on how Hayward Marsh addresses their wet weather capacity issues (or not) and help articulate a vision for future EBDA operations based on the findings from the system-wide assessment on infrastructure condition and Climate Ready Grant.
- EBRPD, HARD, ACFCWCD, City of Hayward, USD, and EBDA investigate opportunities for long-term, coordinated, multi-benefit shoreline protection approaches that would create habitat, re-use treated wastewater, protect inland commercial and industrial areas from flooding, and maintain or improve flood control capacity.

HAYWARD SHORELINE INTERPRETIVE CENTER (HSIC)

Asset Description: This 4,180 square foot educational and resource center contains classrooms, art exhibits, and aquariums with San Francisco Bay animals. The Hayward Shoreline Interpretive Center (HSIC) introduces 9,000 students and adults to the ecology of the Bay each year through field trips, educational programs, art exhibits and interpretive resources. HSIC is owned and operated by the Hayward Area Recreation and Park District (HARD), which has no plans to make major changes to the center. HSIC serves students and adults from around the Bay Area, primarily the 270,000 residents within the HARD service area including Hayward, Castro Valley, and San Lorenzo.

Key Issue Statement: The HSIC is physically vulnerable to sea level rise and storm events because of its non-resilient construction, low elevation and location in the floodplain. HSIC is also vulnerable because it relies on marshes, managed ponds, and trails to provide its education and interpretation services. As marshes drown, levees around managed ponds are overtopped, and trails are eroded, the center will not be able to provide high quality, experiential education about shoreline ecosystems.

Vulnerabilities

FUNC1: Since HSIC depends on trails and marshes for educational interpretation purposes, sea level rise and storm event changes to the natural environment will also affect the function of the interpretive center. Without healthy marshes and usable trails, the center cannot provide high quality, experiential education.

PHYS1: HSIC is within the current 100-year floodplain, and sea level rise and storm events will increase flood risk of this asset. While the HSIC is a raised structure, the floor of the building was built at 12.3 feet (NAVD88) so there is minimal clearance above high water levels such as King Tides (approximately 9 feet). The building relies on water, sewer, and electric lines that are suspended underneath the floor. These utility lines are susceptible to rust and lateral movement so they are very vulnerable to early flooding. If the utility lines were damaged, the HSIC would be unable to function until they were repaired.

PHYS2: HSIC is not constructed of waterproof materials and contains electronic equipment, such as aquariums, computers and power supplies that would be damaged by even short-duration flooding.

Consequences

Society and Equity: HSIC reaches over 9,000 students and adults each year through their educational programs. If the HSIC is temporarily or permanently closed or relocated, these people will lose recreation and educational services.

Environment: HSIC helps Bay Area residents develop a personal connection with the Bay, marsh habitat, and endangered species. If HSIC closes or is relocated, people may be less willing to fund and/or support habitat protection and restoration.

Economy: HSIC generates over $60,000/year in revenue for HARD and employs nine full and part time naturalists. If HSIC is temporarily or permanently closed, this revenue and the jobs the center provides would be diminished or lost.

Proposed Actions

- Work with local and regional partner agencies to plan and fund repairs of trails and levees in the Hayward Regional Shoreline with existing problems or deferred maintenance.
- Work with local and regional partner agencies to develop a Hayward Regional Shoreline Bay Trail management plans that identify funding, regulatory oversight, maintenance, and operational approaches to address damage as well as short and long-term disruptions.
- Support all efforts to improve the resilience of the tidal marshes and ponds within the Hayward Regional Shoreline to maintain habitat, biodiversity, and educational value.
- Develop programs that can be held within the center, rather than those that rely on the trails, for days when there are short-term disruptions of the Bay Trail due to flooding.
- Improve the ability of the center to withstand short-duration flooding by staging temporary flood protection materials (sandbags or barriers) or by investing in permanent flood protection (e.g., waterproofing).
- Permanently elevate and enclose sensitive mechanical or electronic equipment.
- Develop strategies to temporarily elevate or protect sensitive mechanical or electronic equipment.
- Eliminate sensitive mechanical or electronic equipment that cannot be elevated or otherwise protected.
- Develop programs that can be held at off site locations during longer duration flood events and during any recovery efforts.
- Work with local and regional partners to relocate the center to a shoreline location that is not at risk of flooding due to sea level rise or storm events.
- Hold all programs off site and visit the shoreline on days when it is accessible if determined safe for the public to enter.

HAYWARD WATER POLLUTION CONTROL FACILITY (HWPCF)

Asset Description: The wastewater treatment facility serves 148,800 people and industrial and commercial businesses in the City of Hayward. The original facility was constructed in 1954. The current facility includes numerous improvements and expansions, such as the Hayward Effluent Pump Station (HEPS) constructed in the 1980s that lifts secondarily treated wastewater into the centralized East Bay Dischargers Authority (EBDA) discharge system.

The HWPCF is owned and managed by the City of Hayward, while the HEPS is owned by EBDA and managed by the City of Hayward. Average wet weather flows are 18.5 million gallons per day (MGD), while average peak wet weather flows are 25.6 MGD (and maximum capacity rights are 35 MGD within EBDA system). Regular preventative maintenance is the most common maintenance performed (approximately $5 million per year). Master Plans are completed to identify and implement improvements to enhance reliability and redundancy. For example, there are redundant components to treat dry weather flows, an emergency generator to power the plant, and 240-acre oxidation ponds for wet weather flow storage. The City of Hayward is currently finalizing Master Plan Phase 2, which directs how to spend $110 million over the next 20 years. Improvements may include moving the HEPS from its current location approximately 1 mile from the facility onto the property and enclosing the final effluent channel, which runs parallel to the shoreline along the Alameda County Flood Control Water Conservation District flood control channel Line E. Revenues are based on service charges and revenue allocation decisions are taken to the Hayward City Manager for approval by Hayward City Council.

Key Issue Statement: The oxidation ponds that are used for wet weather flow storage are in the existing coastal floodplain and sea level rise will increase flood risk. Without the oxidation ponds, the HWPCF would need new procedures to handle wet weather flows and decisions about capacity and improvements would need to be coordinated with EBDA. If a landscape-scale sea level rise adaptation strategy is not pursued, flooding of the HWPCF will damage electrical and mechanical components at or below grade and compromise system performance.

Vulnerabilities

GOV: Since the HWPCF discharges all of its effluent through EBDA pump stations and pipes, it must coordinate some decisions about capacity and improvements with EBDA, which may delay or complicate efforts to make the facility more resilient.

FUNC1: The HWPCF relies on oxidation ponds for wet weather storage, and if the ponds cannot be protected from sea level rise, the plant will need new procedures to handle wet weather flows.

FUNC2: The HWPCF relies on roads and highways to bring employees, fuel, and other materials to the site. If the area around the plant experiences extensive flooding, plant operations will be disrupted.

PHYS1: The levees around the oxidation ponds that provide wet weather storage are not high enough to protect from the current 100-year storm event and sea level rise will increase flooding.

PHYS2: Many electrical and mechanical components of the HWPCF such as control panels are at or below grade and are not waterproofed or salt-resistant.

Consequences

Society and Equity: HWPCF provides a critical public health and safety function. If storm events or sea level rise shut down the facility, even temporarily, untreated wastewater could back up into homes, businesses, and neighborhoods and spread disease.

Environment: Storm event and sea level rise flooding that overflows the open final effluent channel, but does not shut down the plant, would shut down the HEPS and release secondarily treated wastewater into the surrounding marshes. More severe flooding that shuts down the plant would mobilize fuel, polymer, and sodium hypochlorite and release untreated wastewater into the surrounding marshes and the Bay. Toxic substances and excessive nutrients degrade water quality and harm fish and other aquatic organisms.

Economy: Storm event and sea level rise flooding could increase operations and maintenance and capital improvement costs. For example, loss of the oxidation ponds would require an alternative wet weather storage facility. In addition, the HWPCF serves many local industrial businesses, so disruption of the plant would trigger additional losses to these businesses and employees that work there. Severe flooding would require rebuilding the plant. Rebuilding the plant to meet current codes and standards could cost approximately $500 million.

HWPCF Proposed Adaptation Actions

- Complete Master Phase 2 improvements to move the HEPS further inland and enclose the final effluent channel.
- Develop an agreement with EBDA that articulates shared objectives, decision-making, and funding responsibilities for addressing sea level rise and storm event impacts on system performance, especially related to how to handle wet weather flows.

OLD WEST WINTON LANDFILL

Asset Description: The Old West Winton Landfill is a closed, capped and monitored solid waste disposal site. The landfill was closed in 1974 and since then has been owned by the City of Hayward. Waste Management Corporation conducts leachate monitoring quarterly. No contamination has been observed at the site, but due to the age of the landfill, little is known about its contents.

Key Issue Statement: Old West Winton Landfill is capped and monitored, but little is known about the contents of the site. As sea level rises, the cap may be exposed to wave erosion, saltwater intrusion, and standing water that it was not designed to withstand. If the landfill is not protected from the Bay, hazardous materials could enter the Bay.

Vulnerabilities

INFO: Since there is very little known about the contents and construction of the landfill (operated before regulations were in place), it is difficult to accurately assess its vulnerability and risk.

GOV: Moving the landfill would require extensive permitting as well as an inland site to rebury the contents, which would be extraordinarily expensive.

PHYS: The Old West Winton Landfill cap was not designed for wave action, which will increase with sea level rise. Erosion of the cap may expose landfilled materials to the Bay.

Consequences

Society and Equity: None

Environment: If the landfill cap erodes, unknown and possibly hazardous materials could enter the Bay and adjacent marsh habitat. This would negatively impact plants and wildlife, including threatened and endangered species.

Economy: If the landfill cannot be protected in place from sea level rise impacts, it would create a serious financial liability for the City of Hayward if it must be removed.

City of Hayward Proposed Adaptation Actions

- Review existing information and test landfill contents to support planning for sea level rise, storm events, and elevated groundwater levels
- Protect the landfill cap from wave erosion, saltwater intrusion, and standing water, e.g., coarse beach or armoring to prevent erosion and cutoff walls to prevent saltwater intrusion

OLIVER SALT PONDS

Asset Description: The Oliver Salt Ponds are 98 acres of former commercial salt ponds within the Hayward Regional Shoreline. The Hayward Area Recreation District (HARD) acquired the ponds from The Oliver Salt Co. in 1983 and voluntarily enhanced this state designated historic landscape in the early 2000s for better shorebird and waterfowl habitat. The management plan was updated in 2002 to account for the changes. While the outboard levees were repaired and raised in 2012 (following the 2005 - 2006 New Year's Eve Storm), extreme tides flow through the HARD Marsh and overtop some of the Oliver Salt Pond inboard levees. HARD does not have a funding source to raise the inboard levees and address this flooding, which compromises the snowy plover nesting season.

1954 Photograph of salt ponds north and south of the approach to the Hayward-San Mateo Bridge (SR-92; note, Oliver Salt Ponds are in the lower right portion of the image). Beginning in the 1850s, salt farmers built ponds and levees, bringing Bay water into deep concentrating ponds, and then moving the brine to increasingly shallower ponds, allowing the sun and wind to do the work of evaporation (courtesy of Hayward Area Historical Society).

Key Issue Statement: Oliver Salt Ponds rely on levees and tide gates to manage water levels and sea level rise will make it increasingly difficult to maintain these levels, resulting in progressively more ponding and worse drainage. As water levels change and topography doesn't, the inundation regime and hence the habitats and species therein will inevitably change. The management plan does not consider sea level rise and storm event impacts on the system. Oliver Salt Ponds provide educational value and flood protection

benefits that will not be sustained if the ponds are flooded.

Vulnerabilities

GOV1: While there is a management plan, it does not consider sea level rise and storm event impacts, which limits HARD's long-term ability to maintain the system as is.

GOV2: The lack of a clear funding source to manage the Oliver Salt Ponds has already reduced the quality of nesting habitat and more funding will be needed in the future to address sea level rise impacts.

FUNC: Oliver Salt Ponds provides educational value for the Hayward Shoreline Interpretive Center (HSIC) and some wildlife habitat (snowy plover numbers have been down in recent years, perhaps in part due to superior habitat in Eden Landing) and flood protection benefits to the San Mateo-Hayward Bridge (SR-92) approach. These benefits would be lost or diminished if sea level rise progressively results in more ponding and worse drainage.

PHYS: Oliver Salt Ponds are managed ponds and sea level rise will increase the frequency of overtopping outboard and inboard levees and delay drainage.

Consequences

Society and Equity: The Oliver Salt Ponds provide educational value for the HSIC and the loss of the ponds would result in the loss of historic features and cause changes to the educational program.

Environment: There may be minimal consequences to losing the Oliver Salt Ponds for waterfowl and shorebirds, including species migrating on the Pacific Flyway, because there is habitat available for these species in Eden Landing.

Economy: The Oliver Salt Ponds buffer the San Mateo-Hayward Bridge (SR-92) approach from wave erosion. As sea level rises, overtopping and poor drainage of the Oliver Salt Ponds may affect drainage of the approach, e.g., backwater effect.

HARD Proposed Adaptation Actions

- Review existing management plan and evaluate feasibility of updating existing operations and maintenance given storm event and sea level rise impacts.
- Partner with EBRPD to engage resource managers and agencies, particularly the South Bay Salt Pond Restoration Project and California Department of Fish and Wildlife, to articulate shared goals, decision-making, and funding responsibilities for addressing sea level rise and storm event impacts on tidal marshes and managed ponds in the Hayward Regional Shoreline.
- Depending on operations, maintenance and improvement decisions, determine whether improvements to outboard and inboard levees are timely and cost-effective to prevent overtopping and coordinate with the South Pond Restoration Project to explore new ways to meet HSIC's education program needs.
- Partner with EBRPD, ACFCWCD, City of Hayward, and EBDA to investigate opportunities for long-term, coordinated, multi-benefit shoreline protection approaches that would create habitat, protect inland commercial and industrial areas from flooding, maintain or improve flood control capacity, and re-use treated wastewater.

RUSSELL CITY ENERGY CENTER

Asset Description: The Russell City Energy Center (Energy Center) is a natural gas-fueled power plant that provides 619 megawatts (MW) of electricity to the Bay Area. The plant went online in August 2013 and has an expected lifespan of 40 years. The plant is owned and operated by CalPine, which sells the majority of its power to PG&E through operating agreements. The plant generates enough electricity for 600,000 residents and pays $5 million in taxes to the City of Hayward annually.

Key Issue Statement: The Energy Center is vulnerable to sea level rise impacts because of its reliance on water, access roads, and other utilities that are vulnerable to storm surge and sea level rise. Information about plant operations are not publicly available, which makes it difficult to adequately consider the plant in sea level rise adaptation planning. While the plant may not be vulnerable to more serious flooding impacts since it has an expected lifespan of only 40 years, the site will need to be cleaned up and/or protected as sea level rises.

Vulnerabilities

INFO: CalPine, a private entity, owns and operates the Energy Center, and management and operations plans are not publicly available, making it difficult to adequately assess the plant's vulnerability and risk.

FUNC: The Russell City Energy Center requires 2 million gallons per day of cooling water from Hayward Water Pollution Control Facility (HWPCF) and also discharges wastewater to the HWPCF. In addition, it relies on streets, roads, and highways for employee access. The dependence of the plant on potentially vulnerable utilities may cause the plant to be vulnerable before the plant itself is exposed to flooding, since the plant requires the cooling water and the road access to operate.

Consequences

If the Energy Center were temporarily disrupted or permanently closed, local and regional benefits would be lost. Locally, the benefits lost would be 30 jobs and $5 million in taxes to the City of Hayward. Regionally, the benefits lost would be 619 MW of power (enough to power about 600,000 homes), which could trigger price increases. The temporary or permanent shutdown of the Energy Center would not lead directly to power outages because there is redundancy in the electricity supply grid.

CalPine Proposed Adaptation Actions

- Participate in collaborative adaptation planning discussions about protecting assets in place and/or realigning shoreline infrastructure.
- Plan and prepare for disruptions in services like fuel supply, water supply, water discharge and access roads as sea level rise and storm event impacts increase.
- Increase inspection and maintenance of infrastructure that is sensitive to water or salt in areas at risk from sea level rise, storm events, or elevated groundwater levels.
- Identify utilities and facilities that the energy center relies on and either increase reliability or build redundancy to reduce the chance or intensity of a disruption in service.

SALT MARSH HARVEST MOUSE PRESERVE

Asset description: Salt Marsh Harvest Mouse Preserve is a 27 acre, muted tidal system within the Hayward Regional Shoreline created specifically to protect critical habitat for salt marsh harvest mice. Managed by East Bay Regional Parks District (EBRPD), the marsh was restored in 1985 (during the creation of the Hayward Marsh) to protect critical habitat for salt marsh harvest mice. While no major changes are planned within the marsh, EBRPD recently acquired landward seasonal wetlands to improve drainage (and prevent flooding of adjacent industrial development).

Key Issue Statement: While combination gates allow for more flexible water level management, sea level rise will make controlling water levels more challenging and will require additional engineering to preserve tidal circulation, sediment transport, and gravity drainage, all of which maintain marsh elevations relative to sea level. Without re-engineering, sea level rises will result in progressively more ponding and worse drainage, effectively drowning the marsh and the species therein. Since recently acquired land does not offer much high ground, the marsh has no room to migrate landward to avoid being squeezed and drowned by a rising Bay. Without adaptation planning, EBRPD may not be able to maintain the marsh as sea level rises. The Salt Marsh Harvest Mouse Preserve provides critical habitat for salt marsh harvest mice and flood protection benefits to the adjacent industrial development that will be lost if the marsh converts to mudflat.

Vulnerabilities

GOV: While the 2013 EBRPD Master Plan states its commitment to the protection of tidal marsh habitat, there is not yet a long-term strategy to improve the resilience of marsh habitat as sea level rises. EBRPD may need to revise its management objectives for the Salt Marsh Harvest Mouse Preserve because it will become increasingly difficult to maintain the marsh as sea level rises because it requires managing water levels.

FUNC: The Salt Marsh Harvest Mouse Preserve provides critical habitat for salt marsh harvest mice and reduces flood risk for inland industrial development that will not be sustained if the marsh converts to mudflat.

PHYS1: Salt Marsh Harvest Mouse Preserve is a muted tidal system, where tides flow through combination gates at the back of the HARD Marsh. While combination gates allow for more flexible water level management, sea level rise will make controlling water levels more challenging and may require additional engineering to preserve tidal circulation, sediment transport, and gravity drainage, all of which maintain marsh elevations relative to sea level.

PHYS2: The Salt Marsh Harvest Mouse Preserve is backed by seasonal wetlands and industrial development. Without grading or land use changes, there is not enough high ground to support marsh landward migration to avoid being squeezed by a rising Bay.

Consequences

Society and Equity: There are minimal consequences because the marsh is closed to the public.

Environment: The Salt Marsh Harvest Mouse Preserve provides critical habitat for federally endangered salt marsh harvest mice. Storm event flooding makes salt marsh harvest mice more vulnerable to predation and can reduce reproductive success if nests are flooded. Salt marsh harvest mice prefer mid and high marsh, so downshifting will reduce available habitat and conversion of marsh to mudflat will result complete loss of the species.

Economy: The Salt Marsh Harvest Mouse Preserve is part of the first line of defense against coastal flooding of the adjacent industrial development, which could be damaged if Salt Marsh Harvest Mouse Preserve and its natural flood protection benefits were lost.

EBRPD Proposed Adaptation Actions

- Factor sea level rise into plans for recently acquired land behind Salt Marsh Harvest Mouse Preserve, e.g., consider channel along Breakwater Ave. as inundation pathway and creation of high ground.
- Determine feasibility of updating existing management plans to factor in storm events and sea level rise.
- Partner with HARD to engage resource managers and agencies, particularly the South Bay Salt Pond Restoration Project and California Department of Fish and Wildlife, to articulate shared goals, decision-making, and funding responsibilities for addressing sea level rise and storm event impacts on tidal marshes and managed ponds in the Hayward Regional Shoreline.
- Based on meeting outcomes, develop a marsh sea level rise adaptation strategy, form partnerships to monitor and identify when the marsh is approaching thresholds for possible interventions, and conduct hydrologic, geomorphic, and ecological analyses to determine the feasibility of possible interventions, e.g., islands to create high tide refugia and improve channel density or rainbowing to increase sedimentation on the marsh plain.
- Partner with City of Hayward, ACFCWCD, HARD, and EBDA to investigate opportunities for long-term, coordinated, multi-benefit shoreline protection approaches that would maintain or create marsh habitat, improve flood control capacity in Zone 4, protect inland commercial and industrial areas from flooding, and reuse treated wastewater.

SOLAR PANELS IN OXIDATION PONDS

Asset Description: The City of Hayward installed 5,152 solar panels in 2011 as part of its Climate Action Plan to diversify its energy portfolio and reduce the City's reliance on greenhouse gases. The installation covers around eight acres of the 240-acre oxidation pond and provides one megawatt of electricity for the Hayward Water Pollution Control Facility (about 20% of the total electricity use for the plant). The panels also allow the City of Hayward to claim solar energy rebates worth more than $2.5 million.

Key Issue Statement: The solar panels are located in former oxidation ponds that are not adequately protected from future storm event and sea level rise flood impacts. It may not be possible or feasible to protect the solar panels in their current location. Relocation would require alternate space on city property and connections to the power grid.

Vulnerabilities

PHYS: The solar panels are in out-of-service oxidation ponds located in an area vulnerable to increased flooding due to storm events and sea level rise. While they are elevated above the ground, the components are not waterproof or salt tolerant, and they were not built to be standing in water.

Consequences

If the City of Hayward cannot protect or relocate the solar panels, the 1 megawatt of subsidized, renewable energy they provide will be lost.

City of Hayward Proposed Adaptation Actions

- Waterproof or elevate sensitive electronic components to protect them from standing water
- Improve levees and berms that protect the solar panels from flooding
- If shoreline protection cannot be adequately improved, relocate the solar panels to an alternate, inland city property

State Route 92 (SR-92)

Asset Description: SR-92 was constructed 1967 and carries six lanes of traffic. The portion of the state route under consideration includes the toll plaza and eastern approach to the San Mateo-Hayward Bridge from the Clawiter Road on-ramps. SR-92 is managed by Caltrans. It is a regionally significant commuter movement corridor and carries 86,000 passengers and 1,800 transit riders per day between Alameda and San Mateo counties. The San Mateo-Hayward Bridge is part of the planned Bay Trail alignment although there is not currently pedestrian or bicycle access to the bridge. The bridge is part of the state and regional transportation network and serves local and regional residents as well as visitors.

Key Issue Statement: SR-92 has existing stormwater drainage issues that will be exacerbated by sea level rise and storm events. Any repairs or modifications to the approach, toll plaza, or bridge will be expensive, require extensive permitting due to surrounding marshes, and disrupt regional commuter movement. There is no local alternative for commuters during disruptions or repairs of SR-92, and the nearest alternative Bay crossing (the Dumbarton Bridge) has similar sea level rise and storm event exposure and vulnerability.

Vulnerabilities

INFO1: Planning-level (non-engineering) data, much of it in GIS format, is available and accessible to Caltrans staff and available upon request for other agencies and the general public. Design and survey-grade data is also available, but somewhat more challenging to acquire.

INFO2: Design and survey grade data for SR-92 can be challenging to obtain as it is catalogued on a project-by-project basis. No agency-wide, centralized database exists for this type of data. The Caltrans Document Retrieval System (DRS) is a searchable repository of project plans, however information is stored on a project by project basis as PDFs that are not geo-referenced and finding desired files is difficult for any other than the Caltrans Project Manager or those with institutional knowledge.

GOV1: The information needed to fully understand vulnerability and risk of SR-92 is housed as institutional knowledge with particular project managers and engineering staff. Caltrans staff are primarily funded to support the delivery of transportation improvement projects and there is no formal mechanism for them to provide input on efforts like adaptation planning projects.

GOV2: Regulatory oversight for maintenance, upgrade, or repair of SR-92 could be lengthy. For example, a Biological Opinion by United States Fish and Wildlife Service can take up to 18 months, and obtaining all the necessary permits that could be required for significant work could take 2-3 years, e.g., from San Francisco Bay Permit (BCDC), Section 404 (USACE), 401 Certification (RWQCB), Biological Opinion (USFWS), CESA compliance (CADFW).

GOV3: Maintenance costs for SR-92 are funded by Caltrans; however overall Caltrans resources are not adequate to achieve all of the maintenance needed in the region and therefore the expenditure of funds has to be prioritized. There are no assurances that resources to maintain, upgrade, or repair SR-92 will be available when needed.

GOV4: Caltrans operates a drainage system that discharges to the City of Hayward or Alameda County Water Conservation and Flood Control District (ACWCFCD) stormwater and flood control assets. Both the City of Hayward and ACWCFCD have limited financial resources for repairs, upgrades, and retrofits of stormwater and flood control infrastructure. Although the Caltrans hydrology unit works with cities and ACWCFCD to coordinate on drainage and flood control, how these agencies would share planning or

funding for future upgrades is unknown. The capacity of the SR-92 drainage system to continue functioning as the Bay rises is unknown.

FUNC1: There is no adequate local alternative to SR-92 to cross the Bay as sea level rises since the Dumbarton Bridge has a similar approach and sea level rise and storm event vulnerability and both bridges move significantly numbers of vehicles during peak periods. The loss of one of these bridges would result in significant consequences on regional mobility.

FUNC2: SR-92 carries AC Transit Route M, which connects the MTC Communities of Concern in Hayward and Union City to goods, services and jobs on the peninsula. There is no adequate rail or ferry transit public transportation alternative.

PHYS1: The western portion of SR-92 (west of Whitesell Road) is within the existing 100-year floodplain. Flood risk in this already low-lying area will increase in extent, depth and duration as sea level rises.

PHYS2: A high groundwater table can damage at-grade pavement structural sections if they are constantly saturated and cause the need for major dewatering problems for future construction.

PHYS3: Saltwater intrusion and a rising groundwater table may cause corrosion problems for metal pipes, reinforcing in concrete structures, and pump equipment that are necessary to maintain operations of the west bound approach and toll plaza.

PHYS4: Two 2,000 fuel storage tanks are kept on site at the toll plaza. If the tanks are damaged during a storm event diesel, gasoline stored in them could enter adjacent natural areas or the Bay.

PHYS5: The toll plaza for SR-92 contains electrical components that are not protected from flooding and would be damaged by saltwater exposure.

Consequences

Equity: SR-92 carries transit riders to and from MTC Communities of Concern in Hayward and Union City. If SR-92 is damaged or disrupted, these riders may not be able to access jobs or other services since no alternative transportation options serve this corridor. Therefore even temporary disruptions or closures could have significant local and regional impacts.

Environment: Elevated tanks that store fuel for Caltrans maintenance vehicles at the SR-92 toll plaza could pose a risk to local water quality and habitat if they were to topple over or fail during a storm event.

Economy: SR-92 carries 86,000 passengers, 1,600 transit riders and 6,000 trucks each day. Even a temporary closure of the road would have significant impacts on regional commuter movement since there is no local alternative. If the SR-92 Hayward-San Mateo Bridge needed to be replaced, Caltrans estimates it could cost $45 - 132 Million dollars.

Caltrans Proposed Adaptation Actions

- Conduct analysis of the SR-92 drainage infrastructure to determine if the existing system has adequate capacity to continue functioning as sea level rises
- Regularly maintain the existing drainage infrastructure that serves SR-92
- Improve the altrans DRS so that all Caltrans staff can easily access the information needed to plan for sea level rise and storm events

STRUCTURAL SHORELINES

Asset Description: The structural shorelines in the Hayward Resilience Study area consist of outboard and inboard levees with natural areas in between. The outboard levees along the Hayward Regional Shoreline and the northern portion of Eden Landing are non-engineered levees, often strengthened with riprap revetments. These levees date back to the 1850s and are poorly built. The primary function of non-engineered levees is to separate tidal marshes and managed ponds from the Bay. As such, these levees were not built to meet specific design criteria and provide only "ad hoc" flood protection to inland areas. The inboard levee is an engineered levee between the Alameda County Flood Control Water Conservation District's Line E flood control channel and Depot Road.

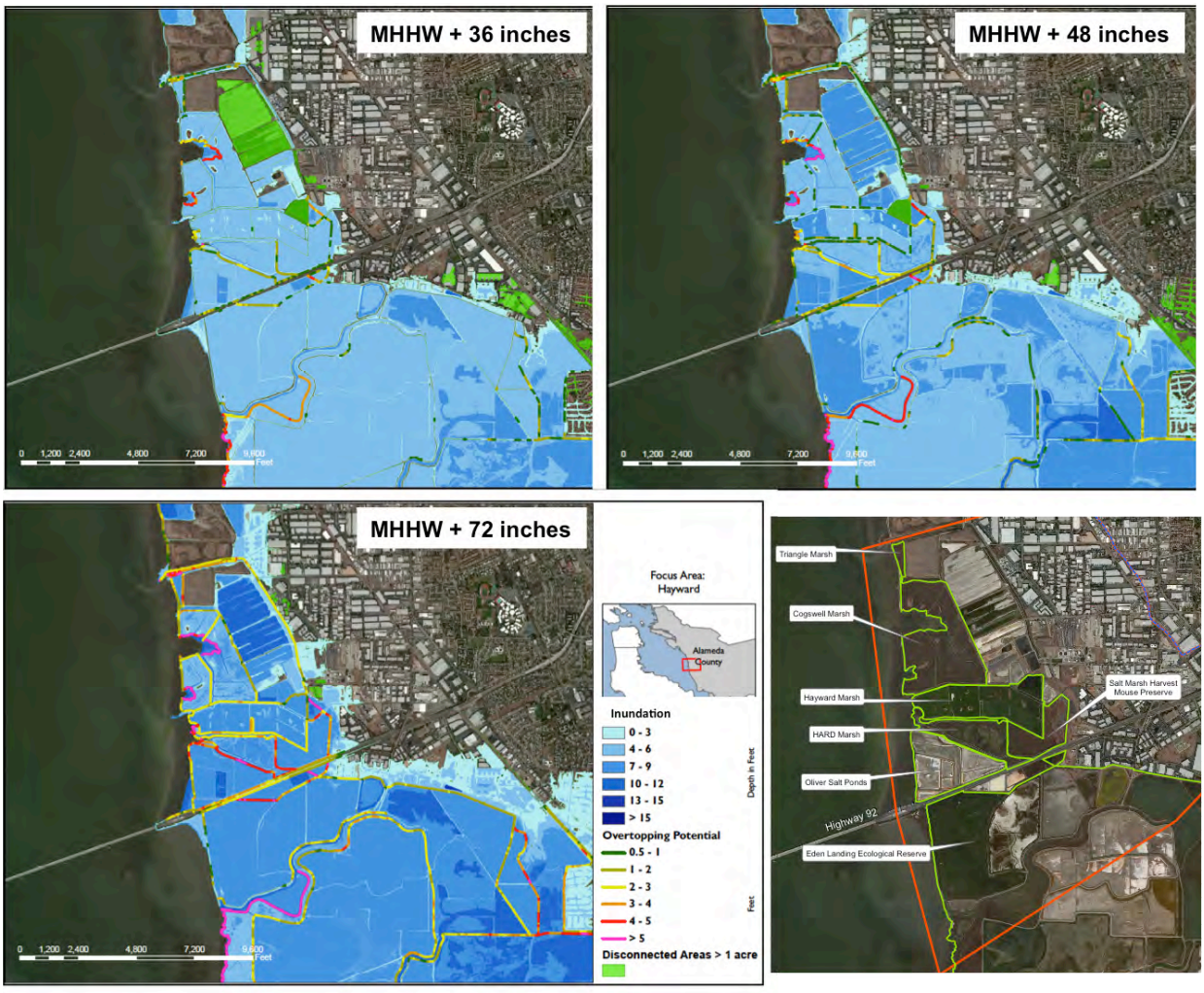
Photographs of representative segments of non-engineered outboard (left) and engineered inboard (right) levees within the study area.

Within the Hayward Regional Shoreline, the outboard levees are managed by East Bay Regional Parks District (EBRPD) and Hayward Area Recreation District (HARD). Shoreline erosion is a common problem, and historical records indicate that the shoreline has eroded approximately 500 feet since the mid-1800s. The outboard levees along the Hayward Marsh are in most need of repair, while the levees along the Oliver Salt Ponds and Triangle Marsh were recently improved by HARD and the levees along Cogswell Marsh have held up well since the 1980 EBRPD restoration. The EBRPD 2013 Master Plan acknowledges the entire Hayward Regional Shoreline "is already facing major expenses for levee repair to protect marsh habitat" and will need to "reserve funding for repair and maintenance of shoreline facilities from storm damage resulting from sea level rise, including the protection of tidal marsh habitat."

EBRPD is currently pursuing a Programmatic Environmental Impact Report (EIR) for routine levee maintenance along the entire Hayward Regional Shoreline. This approach will extend the existing levee maintenance permit cycle beyond five years, replace the need for project-by-project authorizations for large-scale repairs/improvements, and address mitigation requirements more comprehensively. This effort involves assessing levee condition, identifying hot spots, and factoring in short-term sea level rise and storm events. A study of the shoreline indicates that both the inboard and outboard levees are at about the same elevation

and overtop between 36 and 48 inches above mean higher high water (MHHW). This water level occurs in different scenarios and time frames, e.g., 36 inches of sea level rise predicted around 2100 on MHHW, 12" sea level rise predicted around 2050 on a 5-year extreme tide, and a 50-year extreme tide today (NRC (2012)).

California Department of Fish and Wildlife (CADFW) manage structural shorelines within Eden Landing. A study of the shoreline indicates that these non-engineered levees are slightly higher in elevation and overtop between 48 and 72 inches above MHHW. As part of the South Bay Salt Pond Restoration Project, Eden Landing prepared a Programmatic EIR for both tidal marsh/managed pond restoration as well as routine levee maintenance. No restoration is planned in the portion of the Eden Landing within the study area. Under its levee maintenance Programmatic EIR, CADFW can add riprap to its levees on an as-needed basis to maintain existing elevations and then report how much fill is added. Modeling suggests that the extensive managed ponds adjacent to these non-engineered levees will provide substantial flood storage and protection to inland areas for the Eden Landing area.



Inundation maps of Hayward Resilience Study area, with tidal marshes and managed ponds labeled.

Key Issue Statement: The structural shorelines in the study area are mostly non-engineered levees that were not built to meet specific design criteria and provide only "ad hoc" flood protection to inland areas. Lack of a long-term routine levee maintenance program along the Hayward Regional Shoreline makes it difficult to repair storm damage in a timely fashion and sea level rise will exacerbate storm damage and increase the need for maintenance. In addition to the poor design and condition of structural shoreline segments, all of the structural shorelines are at about the same elevation and overtop between 36 and 48 inches above MHHW. This water level translates into a variety of scenarios and time frames between a 50-year extreme tide today and end of century sea level rise on average daily high tides. Since structural shorelines are only as strong as their weakest link, a comprehensive program to ensure that all segments of the shoreline are resilient is needed.

Vulnerabilities

GOV: Within the Hayward Regional Shoreline, there is not yet a routine levee maintenance program, which makes it difficult to perform repairs in timely, low-cost manner due to environmental permitting constraints, e.g., threatened and endangered species and Bay fill issues. Future storm events and sea level rise will increase damage related to erosion and overtopping, which will increase the need and cost of maintenance.

FUNC: Structural shorelines are only as strong as their weakest link, and water that overtop low points especially along the inboard levee system of the study area could flood inland roadways as well as commercial and industrial businesses.

PHYS: Many of the structural shorelines, including the inboard levee along Line E, are too low to protect inland areas against future storm events and sea level rise.

Consequences

Society and Equity: Since the Bay Trail runs on the non-engineered levees within the Hayward Regional Shoreline, erosion and overtopping of these levees will cause temporary disruption of or permanent damage to shoreline recreation and non-motorized commuting that will affect the over 80,000 individuals that visit the shoreline each year. This part of the Bay Trail provides shoreline access for limited-mobility residents, and this access is especially vulnerable because even temporary flooding or debris on the trail can prevent limited-mobility visitors from enjoying the Bay.

Environment: Non-engineered levees protect the West Winton Landfill from releasing hazardous materials into the Bay. In addition, non-engineered levees protect tidal marshes and managed ponds from wave erosion, and erosion and overtopping of these levees would reduce habitat available for threatened and endangered shorebird and waterfowl species.

Economy: Storm damage and failure of outboard non-engineered levees will disrupt the use of the Hayward Regional Shoreline and Bay Trail, which provides over $490,000 in recreation benefits each year (ERG 2011). Storm damage and failure of inboard engineered levees will flood inland roadways and commercial and industrial businesses, such as the Russell City Energy Center, that contribute to the local and regional economy.

EBRPD, HARD, CADFW, ACFCWCD Proposed Adaptation Actions

- EBRPD continues to complete studies and application process for a Hayward Regional Shoreline Programmatic EIR for routine levee maintenance that factors in both earlier term and shorter duration storm events and sea level rise.
- EBRPD prioritizes funding, or identifies funding sources, to complete critical outboard levee repairs along Hayward Marsh to address erosion, overtopping, and subsidence, e.g., adding to existing riprap and maintain slopes.
- EBRPD, HARD, CADFW, and ACFCWCD inspect structural shorelines to identify problems early and maintain as necessary as sea level rises.
- EBRPD, HARD, ACFCWCD, City of Hayward, and EBDA investigate opportunities for long-term, coordinated, multi-benefit shoreline protection approaches that would protect inland commercial and industrial areas from flooding, create habitat, maintain or improve flood control capacity, and re-use treated wastewater.

TRIANGLE MARSH

Asset description: Triangle Marsh is an 8-acre, muted tidal marsh system within the Hayward Regional Shoreline backed by West Winton Landfill. Managed by the Hayward Area Recreation District (HARD), the marsh was restored in 1990 and the tide gates were repaired in 2012. Current management is almost entirely focused on tide gate operation. No major changes are planned.

Key Issue Statement: Maintaining muted tidal action has been difficult and sea level rise will make controlling water levels more challenging, requiring additional engineering to preserve tidal circulation, sediment transport, and gravity drainage, all of which maintain marsh elevations relative to sea level. Without re-engineering, sea level rises will result in progressively more ponding and worse drainage, effectively drowning the marsh and the species therein. Backed by West Winton Landfill, the marsh has no room to migrate landward to avoid being squeezed and drowned by a rising Bay. The lack of adaptation planning may limit HARD's ability to maintain the marsh as sea level rises.

Vulnerabilities

GOV: Current operations do not factor in sea level rise, which may limit HARD's ability to maintain the marsh as sea level rises.

PHYS1: Triangle Marsh is a muted tidal system and there has been trouble in the past maintaining proper flow through the tide gates. Sea level rise will make controlling water levels even more challenging and may require additional engineering to preserve tidal circulation and sediment transport, all of which maintain marsh elevations relative to sea level.

PHYS2: Mudflats protect Triangle Marsh outboard levees from wave erosion and flooding. Sea level rise will decrease this natural shoreline protection because there is less wave height reduction occurs in deeper water.

PHYS3: Triangle Marsh is backed by West Winton Landfill, which is a fixed asset in the landscape, so there is not space for the marsh to move landward and avoid marsh edge erosion and drowning.

Consequences

Society and Equity: There are minimal consequences because there are not extensive views to lose of marsh habitat and species from the Bay Trail given the small size of Triangle Marsh and its location adjacent to the West Winton Landfill.

Environment: There are minimal consequences because the outboard levee protects West Winton Landfill from wave action and potential release of hazardous materials into the Bay. In addition, small marshes have fewer species so increased flooding and loss of vegetation would displace relatively few species.

Economy: There are minimal consequences because Triangle Marsh is too narrow to provide significant flood protection to West Winton Landfill behind it.

HARD Proposed Adaptation Responses

- Determine flexibility of tide gates and evaluate feasibility of updating existing to plans to factor in storm events and sea level rise.
- Engage the City of Hayward as well as resource managers and agencies, such as the East Bay

Regional Park District and California Department of Fish and Wildlife, to articulate the value of Triangle Marsh and the feasibility of interventions, e.g., low-crested berms similar to Hayward's Landing, in context of long-term plans for Old West Winton Landfill.

- Partner with City of Hayward, ACFCWCD, EBRPD, and EBDA to investigate opportunities for long-term, coordinated, multi-benefit shoreline protection approaches that would maintain or create marsh habitat, improve flood control capacity in Zone 4, protect inland commercial and industrial areas from flooding, and reuse treated wastewater.

- Create a system to facilitate the sharing of critical asset information with partner agencies and organizations that are engaged in adaptation planning such as joint hazard mitigation planning efforts or shared asset management databases
- Monitor groundwater and salinity levels near SR-92 at-grade sections other sensitive components by leveraging existing data or collecting site-specific data as needed
- Increase inspection and maintenance of SR-92 water or salt sensitive components in areas at risk of flooding or where increases in groundwater levels are anticipated
- Prepare for flood events by stockpiling materials, establishing turn-key agreements for equipment rental, and pre-positioning emergency power generation capacity, portable pumps, and debris removal equipment
- Install manual, remote control, or automatic temporary barriers or waterproof closures to protect sensitive components, for example at the toll plaza or critical power supplies
- Maintain, repair, or improve the shoreline protection on either side of the highway and toll plaza
- Expand or form multi-agency partnerships to facilitate the planning and funding of multi-objective improvements to SR-92 that would help to reduce or avoid the impact of sea level rise and storm events on inland development and adjacent natural areas
- Conduct an analysis to determine if there are public transportation alternatives that would provide the same level of service to daily commuters either temporarily or permanently
- Install drainage improvements (under or cross drains, backflow or flex valves, perimeter walls or pile/column foundations) to improve the capacity of the existing drainage infrastructure to continue function as sea level rises
- Eliminate the toll plaza or relocate it to an area not at risk of sea level rise or storm events
- Protect SR-92 highway and toll plaza in-place by widening the right-of-way and building levees or seawalls on the shoreline and along both sides on the road or by re-engineering SR-92 to become an elevated causeway.